# ASSESSMENT OF FACTORS INFLUENCING USE OF CLIMATE CHANGE ADAPTATION PRACTICES BY RICE FARMERS IN NORTH-WEST NIGERIA

**BY**

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**A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DOCTOR OF PHILOSOPHY DEGREE IN AGRICULTURAL EXTENSION AND RURAL SOCIOLOGY**

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## DECLARATION

I declare that this work in this Thesisentitled '**Assessment of Factors influencingUse of Climate Change Adaptation Practices by Rice Farmers in North-West, Nigeria'** has been performed by me in the Department of Agricultural Extension and Rural Development. The information derived from the literature has been duly acknowledged and a list of references provided. No part of this Thesiswas previously presented for another degree or diploma at any other institution.

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| Danlami Haruna YAKUBU | Signature | Date |

## CERTIFICATION

This thesis entitled '**Assessment of Factors influencing Use of Climate Change Adaptation Practices by Rice Farmers in North-West, Nigeria'**by Danlami Haruna YAKUBU meets the regulations governing the award of Degree of Doctor of Philosophy Degree in Agricultural Extension and Rural Sociology of the Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literacy presentation.

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# DEDICATION

This thesis is dedicated to my parents with whose love and care, I attained this doctorate level of academic achievement.

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## ACRONYMS

BNRCC: Building Nigeria's Response to Climate Change
CCAP: Climate Change Adaptation Practices
CIMMYT: International Maize and Wheat Improvement Center (a Spanish acronym)
EDO: Ecosystems Development Organization
EEA: European Environment Agency
FAO: Food and Agriculture Organisation
FGN: Federal Government of Nigeria
FMSP: Federal Market Stabilization Programme
FQC: Public Private Partnership
GDP: Gross Domestic Product
GFRA: Global Forest Resources Assessment
GHG: Greenhouse Gas
IAC: Inter Academy Council
IFAD: International Funds for Agricultural Development
IISD: International Institute of Sustainable Development
IPCC: Intergovernmental Panel on Climate Change
KARDA: Kebbi Agricultural and Rural Development Authority
MDGs: Millennium Development Goals
MT: Metric tonnes
MTP: Management Training Plots
NBS: National Bureau of Statistics
NCRI: National Cereals Research Institute
NERICA: New Rice for Africa
NEST: Nigerian Environmental Study/Action Team
NGOs: Non-Governmental Organizations
NIP: National Investment Plan
NIRSAL: National Incentive-based Risk Sharing for Agricultural Lending
NPC: National Population Commission
NRC: National Research Council
NRDS: Nigerian rice development strategy
NSS: National Seeds Service
OECD: Organization for Economic Co-operation and Development
OFDP: Organic Fertilizer Development Programme
PELUM: Participatory Ecological Land Use Management
POST: Parliamentary Office of Science and Technology
PPP: Public Private Partnership
SADP: Sokoto Agricultural Development Project
TAR: Third Assessment Report
UNFCCC: United Nations Framework Convention on Climate Change
USAID: United States Agency for International Development
WARDA: West African Rice Development Association
WHO: World Health Organization

# ABSTRACT

Researches on adaptation-climate change interaction have been conducted mainly in the southern parts of Nigeria with relatively few in North-East and North-Central and seldom, if any, in the North-West. This study, covering three States in the North-West, therefore, will bridge the existing gap in knowledge on climate change adaptation information in Nigeria. It assessed the factors influencing the use of climate change adaptation practices among rice farmers in Kebbi, Sokoto and Zamfara States of North-West Nigeria. This study specifically assessed the perceived effects of climate change on rice production among the farmers, examined the rice farmers' attitude to use of climate change adaptation practices in the study area, determined the factors influencing the use of climate change adaptation practices among rice farmers, and identified and described the constraints to the use of climate change adaptation practices by rice farmers among others. Data were collected from a sample of 522 farmers randomly selected in a multistage sampling procedure. Data were analyzed using both descriptive and inferential statistics. Frequencies, percentages and means were used for data analysis. Chi-square analysis was used to determine the relationship between perceived effects of climate change on rice production and rice yield, the relationship between attitude of rice farmers and use of climate change adaptation practices and the relationship between farmers' use climate change adaptation practices and their level of living. Tobit regression analysis was used to determine the factors influencing the use of climate change adaptation practices by the respondents. Linear regression was used to determine the relationship between factors influencing the use of climate change adaptation practices and perceived effects of climate change on rice production. Results of the data analysis revealed that majority (61.49%) of the respondents fell within the range of 41–60 years of age, were males (93.49%) and married (87.74%) with a household size of 10-19 (57.35%) individuals. Over 55% of them had a formal education. Their mean farming experience was 25.49 years. They had an average rice income of ₦308,742.00. Majority (84.48%) of the respondents used improved rice varieties, intercropping (77.40%), moderate use of fertilizers (93.10%) and chemicals (89.85%)as climate change adaptation practices. Result of the Tobit regression analysis indicated that education, weather information, extension contact, years of cooperative membership and affordability of using climate change adaptation practices were statistically significant ($p<0.01$). Farming experience and farm size were significant ($p<0.05$) while sex was significant ($p<0.10$). Majority of the respondents perceived most of the climate change adaptation practices as affordable, usable and favourable. They, also, perceived that climate change is posing risks to rice production ($\bar{X}=2.16$), would lower rice production ($\bar{X}=2.07$) and would continue to affect storage of rice ($\bar{X}=2.01$).Result of the Chi-square test showed a significant relationship ($p<0.01$) between attitude of the rice farmers to use of climate change adaptation practices and use of the practices with a chi-square value of 12.7952. Majority of the respondents (85.82%) reported low income, high cost of improved rice varieties (83.14%) and poor access to information relevant to adaptation (79.89%) as constraints to use of climate change adaptation practices among others. It was concluded that years of formal education, farm size, climate change awareness, extension contact, years of cooperative membership and affordability of using climate change adaptation practices were the major factors influencing the use of climate change adaptation practices among rice farmers in North-West, Nigeria. Other factors were sex, farming experience and weather information. The need for improving the extension agents-farmer contact by the State governments, making enough credits readily available to farmers and awareness creation campaign by both governments and non-governmental organizations concerned with agricultural development to educate the farmers on the importance of mulching,

planting of cover crops and trees for soil conservation were some of the recommendations made.

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# CHAPTER ONE

# INTRODUCTION

## 1.1. Background to the Study

Climate change is one of the biggest environmental, social and economic threats that the world is experiencing (Mendelsohn *et al*., 2006). It is a threat to the fight against hunger, malnutrition, disease and poverty in Africa and Nigeria in particular, mainly through its impact on agricultural productivity. Agriculture, upon which society depends for the food, feed, and fibre that enable sustainable livelihoods, is one of the sectors that is most vulnerable to shifts in climate (Intergovernmental Panel on Climate Change [IPCC], 2007; National Research Council [NRC], 2010).

Climate change is said to exist when the level of climatic deviation from the normal is very significant over a long period of time (preferably centuries) and such deviations have clear and permanent impacts on the ecosystem (Odjugo, 2009). A drastic change in the climate systems either due to natural forces or unsustainable human activities results in climate change. The latter is regarded as the basic cause of on-going climate change and the advanced countries are most responsible (DeWeerdt, 2007).

Adaptation in the context of climate change is an adjustment in a system in response to actual or expected climatic changes and its impacts. It includes adjustments designed to moderate and offset potential damages or to capitalize on the changes in climate (PELUM 2010). Although climate change adaptation is recognised in Nigeria's development programmes and mainstreaming plans already begun, many policy analysts are of the opinion that policy statements declaring government's intentions are not new and the major limitation is whether appropriate mechanisms are put in place to ensure that the poorest farmers benefit from government's plan (Odozi, 2014).

Rice is Nigeria's most important staple crop, but despite ever-growing demand, the sector remains largely underdeveloped. There is great potential for production, particularly in the north, but Nigeria is actually one of the largest rice importers in the world, importing $3bn per year (Hussaini, 2016). Only 10% of Nigerian rice farmers have access to improved seed stock, compared to 25% in East Africa and 60% in Asia (Gyimah-Brempong *et al.*, 2016), so national production is inevitably sub-optimal.

Rice transformation strategy under the Agricultural Transformation Agenda (ATA) was launched in 2010 by the FGN to make Nigeria become rice self sufficient. The strategy was to produce more paddy and industrial grade milled rice that could compete with imported rice in the market. To this end, 268,000 farmers were given leverage through subsidies in seeds, fertilizers, provision of watering pumps for irrigation farming in ten (10) States of the north namely: Niger, Kebbi, Sokoto, Kano, Zamfara, Bauchi Jigawa Katsina, Kogi and Gombe (FGN, 2011). This indicates the importance of North-West Nigeria and particularly Kebbi, Sokoto and Zamfara States in rice production.

However, variation in weather and climate has led to a lot of devastating consequences and effects in various parts of the country (Odjugo, 2010). These include flooding, deforestation, desertification, erosion, drought, sea level rise, heat stress, pests and diseases, erratic rainfall patterns, and land degradation. When temperature exceeds the optimal level for biological processes, crops often respond negatively with a steep drop in net growth and yield. Khanal (2009), stated that heat stress might affect the whole physiological development, maturation and finally reduces the yield of cultivated crop.

One of the most serious long-term challenges to achieve sustainable growth in rice production is climate change (Wassmann *et al.,* 2007). Rice productivity and sustainability are threatened by biotic and abiotic stresses, and the effects of these stresses can be further aggravated by dramatic changes in global climate. Drought and flood already cause widespread rice yield losses across the globe and the expected increase in drought and flood occurrence due to climate change would further add to rice production losses in the future. Thus the major challenge is the potential adverse effect of changing climate on rice production and being the factor limiting increase in annual yield (Ayinde *et al.,* 2013).

### 1.2. Problem Statement

In terms of rice production in Nigeria, the North-West was second in the year 2013, after the North-Central, with production of 1,294,200 Metric Tonnes which was 28.6% of the country's total(Rapu, 2016).According to Ezedinma (2008) Kebbi and Sokoto States are among the major rainfed upland and irrigated rice ecologies in Nigeria, producing 44% of total domestic production at an average yield of 1.7t/ha and 2.2t/ha for the rainfed upland and irrigated rice, respectively. However, rice farming is highly dependent on environmental factors which are the most important among several factors that influence agricultural production(Onyegbula, 2017).

According to Edeh *et al.* (2011), rice production depends on optimum combination of factors of production in order to achieve remarkable yield. These factors are not limited to the familiar production inputs but include the various environmental factors provided by nature. Rainfall characteristics (intensity and duration), relative humidity and temperature constitute these weather-related and environmental factors that affect rice yield and its variability. Rice production which is one of the world's most important crops for ensuring food security and addressing poverty will be thwarted as temperatures in rice-growing areas, increase with continued change in climate(Gumm, 2010).

Climate change has brought uncertainty to weather conditions in Nigeria most especially in the northern part of the country which accounts for the major food crops produced e.g. rice. Hence, the most viable option for the rice farmers is to use the climate change adaptation practices.

Farmers have a long history of responding to climate variability. Traditional and newly introduced adaptation practices can help farmers to cope with both current climate variability and future climate change. However, the debate about the adaptation of small-scale farmers to climate change has occurred in the absence of knowledge about existing and potential adaptation practices. Because prevailing ideas about adaptation are vague, conducting focused research on potential adaptation practices and formulating appropriate advice for implementing new practices is difficult (Below *et al.*, 2010).

The evident fallout of climate change according to IPCC (2007); Kurukulasuriya and Mendelsohn (2006) can be reduced through adaptation. Although, African farmers have a low capacity to adapt to changes owing to low technological development, poverty and illiteracy, they have survived and coped in various ways. Better understanding of how they have done this is essential for designing incentives to enhance adaptation (Mohammed *et al.,* 2014). Supporting the adaptation strategies of local farmers through appropriate public policy and investment and collective actions can help increase the adaptation measures that will reduce the negative consequences of predicted changes in future climate with great benefits to vulnerable rural communities in Africa and Nigeria in particular (Hassan and Nhemachena, 2008).

Research on adaptation-climate change interaction have been conducted mainly in the southern part of Nigeria (Ajewole and Aiyeloya, 2004; Onyenechere and Igbozurike, 2008; Apata *et al.,* 2009; Ozor, 2009; Nwalieji and Onwubuya, 2012; Ugwoke *et al.,* 2012; Ayanwuyi *et al.,* 2010, Oyerinde *et al.,* 2010; Anyoha *et al.* 2013 and Bako, 2013) with relatively few in North-East and North-Central (Adebayo *et al.,* 2012; Idrisa *et al.,* 2012; Falaki *et al.,* 2013 and Ayinde *et al.* 2013) and seldom if any, in the North-West. Moreover, the information obtained from these studies is not sufficient to represent the whole country as most of the previous studies focused on different agro-ecological zones with different social, institutional and environmental settings. This study, covering three States in the North-West, therefore will bridge the existing gap in knowledge on climate change adaptation information in the North-West and Nigeria in general.

It seems that there is a gap between the rate at which climate is changing and the response to reduce its impact through employment of adaptation strategies that ensure sustainable food security (Mudzonga, 2012). In spite of this, factors that influence farmers' decisions to adapt to climate change in North-West, Nigeria are not well known. This study seeks to investigate the factors that influence farmers' decision to adapt to climate change in order to inform policy formulation that enhances farmers' capacity to adapt to climate change. It investigates the factors influencing climate change adaptation practices among rice farmers in Kebbi, Sokoto and Zamfara States of North-West, Nigeria. Kebbi and Sokoto States were among the fifteen states identified under the Rice Transformation Agenda of the Federal Government of Nigeria (FGN) (The other states were Kano, Niger, Kaduna, Taraba, Adamawa, Kwara, Ebonyi, Cross River, Bayelsa, Borno, Enugu, Ekiti and Ogun). They produce mainly lowland rice. This study intends to answer the following research questions:

i. What are the socioeconomic characteristics of rice farmers in the study area?
ii. What is the level of awareness of climate change by rice farmers?
iii. What are the climate change adaptation practices employed by rice farmers in the area?
iv. What are the perceived effects of climate change on rice production among the farmers?
v. How does the use of climate change adaptation practices among rice farmers affect their level of living?
vi. What are the farmers' attitudes to climate change adaptation practices?
vii. What are the factors influencing the use of climate change adaptation practices among rice farmers?
viii. What are the constraints to the use of climate change adaptation practices by the rice farmers?

## 1.3. Objectives of the Study

The broad objective of the study was to assess the factors influencing the use of climate change adaptation practices among rice farmers in Kebbi, Sokoto and Zamfara States of North-West Nigeria. The specific objectives were to:

i. describe the socioeconomic characteristics of rice farmers in the study area;
ii. determine the level of awareness of climate change by rice farmers;
iii. identify the climate change adaptation practices employed by rice farmers;
iv. assess the perceived effects of climate change on rice production among the farmers;
v. determine the effect rice farmers' use of climate change adaptation practices on their level of living;
vi. examine the rice farmers' attitude to use of climate change adaptation practices in the study area;
vii. determine the factors influencing use of climate change adaptation practices among rice farmers; and
viii. identify the constraints to use of climate change adaptation practices by rice farmers.

## 1.4. Hypotheses of the Study

The following hypotheses were tested:

i. There is no significant relationship between farmers' perceived effects of climate change and rice yield.
ii. There is no significant relationship between factors affecting use of climate change adaptation practices and perceived effects of climate change on rice production.

iii. There is no significant relationship between use of climate change adaptation practices and farmers' level of living.

iv. There is no significant relationship between attitude of rice farmers and use of climate change adaptation practices.

v. There is no significant relationship between the farmers' socioeconomic, institutional and technological characteristics and use of climate change adaptation practices

**1.5. Justification of the Study**

Adaptation has the potential to alleviate adverse impacts, as well as to capitalize on new opportunities created by climate change. Since the Third Assessment Report (TAR) of IPCC in 2001, there has been significant documentation and analysis of emerging adaptation practices. Adaptation is occurring in both the developed and developing worlds, both to climate variability and, in a limited number of cases, to observed or anticipated climate change. However, the end goal of all adaptation is to address climate risks, enhance resilience and reduce vulnerability. Effective adaptation initiatives for peasant farmers according to Gumm (2010) must be put in place. The IPCC (2007) has estimated that adaptation to climate change could cost Africa some 5-10 percent of its gross domestic products; however, both adaptation and mitigation will require the alteration of governments and policy makers in order to coordinate and lead initiatives.

Identifying both the generic and climate-specific elements of farmers' adaptation behaviour is vital in order to facilitate a societal response to the changes in climate that scientists have predicted. Tailoring adaptation practices to specific societies may make it possible to offset the adverse impacts of climate change (Fussel, 2007). With appropriate adaptation practices in place, the vulnerability to climate change will be minimized. Although the issue of climate change and agriculture is not a recent development, there has been little or no efforts aimed at documenting scientifically what the existing situations in northern Nigerian agrarian communities are as regards the various indigenous innovative technologies and adaptation measures embarked upon to combat the negative effects of climate change. The need for such baseline information, especially relating to designing appropriate strategies for mitigating its effect on agriculture, cannot be overemphasized (Farauta *et al.,* 2011).

Climate change is expected to present a heightened risk, new combinations of risks and potentially grave consequences in Africa and Nigeria in particular, due to its direct dependence on rain-fed agriculture. Hence, the need to assess the effect of adaptation practices to climate change mitigation among rice farmers in Kebbi, Sokoto and Zamfara States of North-West Nigeria.

This study when in public domain, would provide information on the factors influencing climate change adaptation practices among rice farmers in Kebbi, Sokoto and Zamfara States. It would help policy makers in designing appropriate policies against the threats of climate change; the social and economic threats, the threat against hunger, malnutrition, disease and poverty in the study area and Nigeria at large. Unless appropriate mitigation and adaptation measures are taken, climate change will frustrate farmers' efforts to achieve sustainable agricultural production and food security. However, developing such strategies will require information from the farmers since the ability to adapt and cope with climate change depends on their knowledge, skills, experiences and other socio economic factors (Maharjan *et al*., 2011).

This study could help farmers in employing the best adaptation practices identified in order to minimize rice losses due to climate change menace. It is important because one of the challenges facing Nigeria as a nation is how to improve the productivity of cereal crops, especially rice that has been marked as a major staple food crop (Julius and Chukwumah, 2014). It could also serve as a baseline and reference material for further research in the study area.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Rice Production in Nigeria

Rice belongs to the family, *Gramineae,* Genus; *Oryza* andspecies:*sativa L.* and *Glaberrima S.* It was brought to West Africa in the early 19 century. It is an annual crop; a seed of monocot plant. Rice is the staple food for about half of the human race (Jirgi *et al.*, 2009). FAO (2006) reported that rice is the second highest worldwide crop produced after maize. It is the leading cereal crop which can be grown in the standing water of areas of flat, low-lying tropical soils. West African Rice Development Association (WARDA) (2003) projected growth in rice consumption for Nigeria as high as 4.5 percent per annum. Today, rice is no longer a luxury food to millions of Nigerians but has become the cereal that constitutes a major source of calories for the rural and urban poor with demand growing at an annual rate of 5% (WARDA, 2003).

During the past three decades, rice has been in a steady increase in demand and its growing importance is evident given its important place in the strategic food security planning policies of many countries (Norman and Otoo, 2006). The challenges faced by countries as regards rice production however differs from one country to the other in terms of population, the preference attached to the commodity in lists of household menu, natural endowment for expanded production and the productivity of the rice farm (WARDA 2003; Ajayi *et al.,* 2000).

Food and Agriculture Organization (FAO) (2000) opined that, globally, annual rice production needs to increase from 586 million metric tons in 2001 to 756 million metric tons by 2030. Sources of such increase are identified as including; increased acreage under high yielding varieties; developing hybrid rice and evolving a more appropriate and efficient crop, soil, water, nutrient management technologies and accelerate technology transfer. All these factors no doubt go a long way in defining the potentials of a country for expanded rice production.

In a study for rice production in Nigeria, Ecosystems Development Organization (EDO) (2003) revealed that the dominant rice systems found in Nigeria are rain-fed field rice, also known as the dry upland system and waterlogged shallow *fadama* field rice system. The rain-fed field rice system is very widespread. It is particularly important in the Savannah zones. The waterlogged shallow *fadama* system is also widespread. It is an important system given the fact that it is practised along the major drainage systems such as the Niger/Benue troughs as well as minor watercourses and tributaries.

In a proposal for Rice Transformation Project, the Federal Government of Nigeria (FGN) (2011) highlighted that total demand for rice in Nigeria is put at about 5million MT a year out which about 3.2 million MT are produced locally. The high cost of importation in recent years has highlighted the desire by the government to encourage import substitution by encouraging increased local production.

It added that the goal of the rice transformation agenda was self sufficiency in rice production and complete substitution of imported rice by year 2014. It specifically intends to develop a vibrant rice value chain that will attract investments for locally produced rice, raise rice production level from current 3.3 million MT to 6 million per year to remove the shortfall between demand and production by year 2014, raise the quality of locally produced rice to international standards and build a network of paddy producers around rice mills to ensure regular supply of paddy.

The strategy of the rice transformation agenda was to identify clusters of lowland and irrigated lowland rice ecologies in the selected states, organize the farmers into cluster groups to aggregate them for access to improved technology – seeds and other inputs- as well as market. Increase in paddy production will be anchored on yield improvement per unit area (intensification) raising average yield per hectare from 1.5 to 6.5 MT per hectare. Farmers were to be linked to credit sources and to the benefits derivable from activities of NIRSAL in the purchase of farm equipment and machinery and rehabilitate existing irrigation schemes to full capacity for paddy production.

Expected output included a viable rice value chain capable of meeting the country's rice demand put in place, conservation of foreign exchange earnings resulting from elimination of rice imports and diversification of Nigerian economy. Others were food security resulting from doubling of rice production from 3 MT/ha to 6.0 MT /ha, income growth and poverty reduction for rice farmers and generation of additional 500,000 jobs in the rural area (FGN, 2011).

According to Ramirez (2010) the challenges for rice production are twofold: coping with population growth while also facing climate change. Unforeseen changes associated with global warming in temperature, carbon dioxide and rainfall are expected to impact on rice production. Ajatomobi *et al.* (2010) noted that the major problems associated with rice production included drought, flooding, salt stress and extreme temperatures, all of which are expected to worsen with climate change. Drastic changes in rainfall patterns and rise in temperatures will introduce unfavourable growing conditions into the cropping calendars thereby modifying growing seasons which could subsequently reduce productivity.

According to PrantillaandLaureto (2013) rice farming is said to be threatened by climate change because of higher temperatures and changing rainfall patterns. Acute water shortages combined with thermal stress could adversely affect rice productivity despite the positive effects of elevated carbon dioxide in the future. Crop diseases such as rice blast, and sheath and culm blight of rice could become more widespread (Jaranilla-Sanchez *et al.*, 2007).

Most rice farmers in Nigeria are smallholders, applying a low-input strategy to agriculture, with minimum input requirements and low output (USAID 2011, IFAD 2009). Estimates indicate that over 90 percent of domestic rice production comes from resource-poor and weakly organized small-scale producers, with average farm size of 1-2 hectares (Ayibiowu, 2010). Hence, Nigeria rice productivity is among the lowest within neighbouring countries, with average yields of 1.51 tonnes/ha. This is one of the reasons for the existence of the gap between demand and supply of rice in the country. The gap is connected with the improper production methods, scarcity and high cost of inputs, rudimentary post-harvest and processing methods, inefficient milling techniques and poor marketing standards particularly in terms of polishing and packaging.

Poor or low mechanization on rice farms means heavy reliance on manual labour to carry out all farm operations. Labour costs on Nigerian farms are driven by opportunity costs of labour (hired) in alternative jobs in the cities like civil service, informal sector jobs e.g. motorcycle taxis riding, street hawking etc. Labour and financial constraints make it more difficult to expand the farm size or increase production base (Daramola, 2005). However, the land mass used for rice cultivation increased from 150,000 hectares in the 1960s to about 1.8 million hectares currently (NCRI/NBS/NISER/UI, 2009).

Anyoha*et al.* (2013) discovered that farm size, educational level, farming experience, household size, cooperative membership and sex were significantly related to climate change adaptation strategies used by the farmers in Umuahia south area of Abia State, Nigeria. Age and occupation were not significant at 5% level indicating that they are variables that do not influence the use of the adaptation strategies in the study area.

### 2.2 Rice Production Policies in Nigeria

As part of macro policy restricting rice imports, previous governments in Nigeria had employed various trade policy instruments such as tariffs, import restrictions, and outright ban on rice import in the past decades. During the 1970s and early 1980s, increased export earnings coupled with subsidies to the Naira exchange rate made it possible for Nigeria to finance huge food imports (Akpokodje and Olaf, 2003). Cadoni and Angelucci (2013) highlighted the following policies on rice production in Nigeria:

#### 2.2.1 Presidential initiative on increased rice production (2002-2007)

Given to the high import bills for rice and the relatively low quality and yields for the cereal in Nigeria, different policy initiatives have been implemented to increase production. Among such policy actions, the Presidential Initiative on increased Rice Production (2002) aimed specifically at reversing the import bill meeting domestic demand by 2006 and reach export capacity by 2007. Main targets were to increase rice production, improve milling quality, and promote marketing to provide domestic rice for consumption and to ultimately reduce national rice importation. The ambitious goal of the Initiative was to produce 15 million Tonne of rice from 3 million ha of consolidated farm land by 2007.

The main activities included: (1) increase production, inputs and crop protection, by increasing yields, enhancing agronomic practices, providing credit to farmers, providing inputs, applying agricultural good practices such as minimum tillage; (2) enhance irrigation and land development schemes through rehabilitation and construction of current endowments; (3) improve processing, marketing and storage; (4) enhance farmers' groups; and (5) seed production (mainly NERICA and Oryza sativa) (Adejumo-Ayibiowu, 2010).

Although the initiative did not reach its final goal, there was a 31 percent increase in rice production between 2002 and 2007. Among the results of the Initiative's application, there were 81 505 supply packages (known as R-Boxes, containing seeds and agro-chemical supplies) distributed in 36 states, the National Seeds Service (NSS) produced 58 tonne of foundation seed, 4.92 tonne of breeder seeds and 25.23 tonne of foundation seed Stage 1 of NERICA and 12.6 tonne of lowland varieties were produced by the National Cereal Research Institute and West African Rice Development Association, while capacity building was enhanced through Management Training Plots (MTP) in 25 states (Odoemena, *et al.*, 2008).

### 2.2.2 Nigerian rice development strategy (NRDS) (2009-2018)

Similarly to the 2002 Presidential Initiative, the NRDS (initiated in 2009) goal is to increase rice production. The target set by NRDS is to raise paddy output from 3.4 million tonnes in 2007 to 12.8 million tonnes in 2018. There are three priorities areas set for enhancement by the Strategy, they are: (1) post-harvest processing and treatment; (2) irrigation development; and (3) input availability, mainly focusing on seeds, fertilizer and farming equipment. NRDS includes a mixture of input supply promotion (such as 50% subsidy for seeds and 25% for fertilizer) and reduced custom tariff on imports of specific agricultural machineries (such as tractors and processing equipment).

The high cost of seeds is currently a constraint on increased production. The National Agriculture Seed Council is in charge of seed production and certification, while the National Cereals Research Institute (NCRI) and the Africa Rice Centre regulate their delivery to producers (Diagne 2011).

### 2.2.3 Presidential initiative on agricultural transformation agenda (2011)

The overall goal of the Agenda is to define agriculture as a business, promote private sector investment in agriculture, along with the development of private sector driven marketing organizations and the promotion of Incentive-based Risk Sharing for Agricultural Lending (NIRSAL). Rice is among the commodities (together with cassava, sorghum, cocoa, and cotton) for which a country-wide commodity-specific transformation plan is envisaged. The final goal of the rice transformation agenda is to reduce the import bill, and make Nigeria self-sufficient within a 5 years' timeframe.

To achieve the goal, the strategy aims at improving rice quality offering a viable alternative to the current imports, aiming for a significant portion of demand in the domestic rice market will shift from parboiled rice to milled rice. Consequently, policies will especially focus on milled rice but also on parboiled rice as a supply side target. Activities focus on enhanced irrigation and mechanization systems, through private sector involvement. For example, incentivize the private sector to invest in large parboiling and de-husking facilities in regions of high current production, such as Niger State and Cross River State.

### 2.2.4 Cross-commodity input support: fertilizer policy

Aside from rice-specific input support policies, there are initiatives that influence rice production, although their specific impact cannot be quantified. Both State and Federal Government can provide fertilizer to farmers as input support. However, contribution varies consistently between one state and the other, and between one year and the other. The Federal Market Stabilization Programme (FMSP) allows companies to produce and import fertilizer and allocate it to state governments with a 25 percent subsidy. Additionally, State Governments can further add to the subsidy.

The National Investment Plan (NAIP) set a target of a 30 percent increase in fertilizer use in the period 2010-2015, with an overall demand expected to grow from 2.6 to 3.4 million tonnes per year by 2015. There are three main initiatives within the NAIP actively targeted towards the increase in fertilizer use: (1) the Organic Fertilizer Development Programme (OFDP) promotes the use of organic fertilizer though a Public Private Partnership (PPP) approach; (2) the Fertilizer Quality Control (FQC) project aims at increasing the quality of fertilizer used and distributed; and (3) the National

Foundation Seed Multiplication aims at releasing high quality foundation seeds to certified producers.

### 2.2.5 Cross-commodity price support measures: guaranteed minimum price

The Guaranteed Minimum Price Programme is the follow-up to the Buyer of Last Resort Grain Programme, formerly run by the Food Reserve Agency. The Buyer of Last Resort Grain Programme's main goal was to develop a buffer stock to respond to shortages of cereals, as well as to influence prices by purchasing cereals when markets prices are below an intervention threshold (WTO Review, 2011). In 2008, in response to the high food prices crises, the Government encouraged producers by indicating that they would prevent prices from falling below a minimum by purchasing excess produce. They also procured 650, 000 tonnes of fertilizer.

## 2.3 Climate Change - An understanding

The Intergovernmental Panel on Climate Change (IPCC) (2007) defines Climate Change as the change in the state of the climate that can be identified by changes in the mean and /or the variability of its properties and that persists for an extended period typically decades or longer. Although the length of time it takes the changes to manifest matters, the level of deviation from the normal and its impacts on the ecology are most paramount (Odjugo, 2010)

Anijah-Obi (2001) conceives climate change as a long-term change in the climate of the earth. While Slater *et al.* (2007) defined climate change as a process of global warming, in part attributable to the greenhouse gases generated by human activity. They noted that climate is the average weather condition of a particular locality, comprising of the various elements of temperature, precipitation and cloudiness.

Ivuerah (2007) reported that, the issue of climate change is interwoven with the basket of six gases, "Green House Gases (GHG) which includes: carbon dioxide (CO2), Methane (CH), Nitrous Oxide (NO), Hydro-fluorocarbons (HFLs), Perfluorocarbons (PFLs), and sulphur hexafluoride (SF2). These greenhouse gases are primarily from the anthropogenic activities that include carbon-dioxide emission from the combustion of fossil fuels, production of cement, bush burning, agriculture and other land use activities (including deforestation).

**2.4 Effects of Climate Change on Agriculture**

Evidence from literature and past studies has revealed that the recent global warming has influenced agricultural productivity leading to declining food production (Kurukulasuriya and Mendelsohn, 2006; IISD, 2007; Lobell *et al.*, 2008). Climate change has already affected crop yields in many countries (IPCC, 2007; Deressa *et al.*, 2008; BNRCC, 2008). This is particularly true in low-income countries, where climate is the primary determinant of agricultural productivity and adaptive capacities are low (SPORE, 2008; Apata *et al.*, 2009).

Climate change impacts on agriculture can be positive or negative. They are dependent on latitude, altitude and type of crop. There have been noticeable impacts on plant production, insect, disease and weed dynamics, soil properties and microbial compositions in farming systems (Khanal, 2009; Rosegrant *et al.*, 2008). Intergovernmental Panel on Climate Change (IPCC) in her synthesis Report on climate change explained how hard it is to find evidence of negative consequences of climate on the world agricultural productivity in aggregate agricultural statistics. One reason is the positive gains from global warming observed in the temperate regions due to reduced risk of frost and longer growing season. The other important reason is that the world agriculture in general but particularly temperate regions had witnessed noticeable increases in productivity of most crops as a result of major technological advances (breeding and improved fertility and pest and diseases management) (IPCC, 2007).

Agriculture depends much on the environment in the process of providing the lives and livelihoods of millions who depend on it for food and subsistence (Prantilla and Laureto, 2013). On the other hand, climate is the primary determinant of agricultural productivity. Climate change impact on agricultural inputs such as water for irrigation, amount of solar radiation for plant growth, and prevalence of pests can affect crop yield and types of crops that can be grown in some areas (Dhaka *et al.*, 2010)

Although there is some evidence that agriculture in temperate regions of the world has benefitted in some ways from global warming the same report states with high confidence that "agricultural production and food security, including access to food, in many African countries and regions are likely to be severely affected by climate change and climate vulnerability". This is because African economies and the livelihoods of its population are highly dependent on agriculture which is mainly practiced in already harsh climatic condition (e.g. high temperature, marginal environment, and considerable water stress) (IPCC, 2007).

The Intergovernmental Panel for Climate Change reported that smallholder and subsistence farmers in developing countries are among those who suffer the most from climate change impacts (IPCC, 2007). Since climate change affects food security in terms of availability, accessibility, utilization, and stability, the negative impacts it brings may lead to a decline in labor productivity, increase in poverty, and increase in mortality rates (Prantilla and Laureto, 2013).

Food and Agriculture Organisation (FAO, 2008) argues that many countries worldwide are facing food crises due to conflict and disasters, while food security is being adversely affected by many factors including droughts and floods linked to climate change. Climate change in the form of higher temperatures, reduced rainfall and increased rainfall variability, reduces crop yields and threatens food security in low income based economies (Mudzonga, 2012).

Rough estimates suggest that over the next 50 years or so, climate change may likely have a serious threat to meeting global food needs than other constraints on agricultural systems [IPCC, 2007; Building Nigeria's Response to Climate Change (BNRCC, 2008)]. Specifically, population, income, and economic growth could all affect the severity of climate change impacts in terms of food security, hunger, and nutritional adequacy.

Climate change, which is attributable to the natural climate cycle and human activities, has adversely affected agricultural productivity in Africa (Ziervogel *et al*., 2006). It affects agriculture in several ways, including its direct impact on food production. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC,

2007) predicts that climate change is likely to have a significant effect on agricultural production in many African countries. Projected reductions in yield in some African countries could be as much as 50% by 2020, and net crop revenues could fall by 90% by 2100 (Boko *et al*., 2007).

Between 1960 and 1998 a decline in mean annual precipitation of between 20% and 40% has been noted in West Africa compared to a 2% to 4% decline in tropical rain forest regions (IPCC, 2007). It is also important to note that rural people and agricultural production in Africa rely on rainfall for water supply with as little as less than 4% of cultivated land under irrigation (Inter Academy Council [IAC], 2004; World Bank, 2008).

The predominance of rain-fed agriculture, the scarcity of capital for adaptation measures, their warmer baseline climates and their heightened exposure to extreme events (Nnamchi & Ozor, 2009) reportedly in Africa agriculture to be more vulnerable to climate change. Food crop is particularly sensitive to climate change because crop yields depend largely on prevailing climate conditions (temperature and rainfall patterns) (Palatnik & Roson, 2009).

Although African farmers have a low capacity to adapt to changes, they have, however, survived and coped in various ways over time. Better understanding of how they have done this is essential for designing incentives to enhance private adaptation. Supporting the coping strategies of local farmers through appropriate public policy and investment and collective actions can help increase the adoption of adaptation measures that will reduce the negative consequences of predicted changes in future climate, with great benefits to vulnerable rural communities in Africa (Hassan and Nhemachena, 2008).

Many African countries, which have their economies largely based on weather-sensitive agricultural productions systems like Nigeria, are particularly vulnerable to climate change (Dinar *et al.*, 2006). This vulnerability has been demonstrated by the devastating effects of recent flooding in the Niger Delta region of the country and the various prolonged droughts that are currently witnessed in some parts of Northern region. If climate change adversely affects agriculture, effects on human are likely to be more severe in a poorer world (Apata, 2012). Climate change, induced by the increasing concentration of greenhouse gases in the atmosphere, is likely to affect crop yields, agricultural productivity, and food self-sufficiency in rice production in Nigeria through changes in temperature, precipitation and extreme climate conditions such as drought, storms, and flooding (Odozi, 2014). This amounts to a serious threat to food security and to the achievement of major developmental goals.

Nigerian agriculture is already under significant pressure to meet the demand of rising population using finite, often degraded soil and water resources, which are now further stressed by the impact of climate change (Awotoye and Mathew, 2010). As a result, it is of interest to stakeholders in the agricultural sector to understand the kind of impact climate change will have on food and crop production. There will undoubtedly be shifts in agro-ecological conditions that will warrant changes in processes and practices in order to meet daily food requirements. In addition, climate change could become a significant constraint on economic development in developing countries that rely on agriculture for a substantial share of gross domestic production and employment (Rosegrant *et al.*, 2008).

In Nigeria, it is a well known fact that climate has varied in time and space, and that it will continue to vary in future (Ojo, 1987). In Southeast Nigeria, droughts have been relatively less persistent, while rainfall is observed to be increasing and temperature increases and reduces moderately over the years compared with Northern Nigeria (Okorie *et al*., 2012). In North-eastern Nigeria, drought caused death of many animals and about 60% drop in crop yield (IPCC, 2007).

In Oyo, South-western Nigeria, flooding caused 30 deaths and displaced nearly 2000 people (Nigeria Metrological Agency, 2008). In Anambra State, farmers depend on the natural environment for their livelihood due to poverty and paucity of resources. According to Nwalieji and Uzuegbunam (2012), in 2012, the rice farmers in the state suffered reduction in crop yield and grain quality, reduction of farmland by flood, high incidence of weeds, pests and diseases, decrease in soil fertility and the surge of human diseases such as meningitis, malaria and cholera.

No part of Nigeria is safe from climate change. For instance, more than two thirds of the country is prone to desertification. States, such as Borno, Sokoto, Jigawa, Zamfara, Kebbi, Yobe, Kaduna, Kano Bauchi, Adamawa, Bauchi, Niger and others are at risk. In the Sahel zone of northern Nigeria, the most pronounced climate change-related forms of land degradations are wind erosion and related sand dune formation, drought and desertification (Farauta *et al.,* 2011). In south-eastern Nigeria, sheet erosion which is the complete removal of arable land is a major threat to agriculture in the region.

Apart from the effects on cropping pattern, climate change brings with it proliferation of pests and diseases; these can hinder storage when the need arises because of temperature increases. Diseases tend to spread to area where they were previously unable to thrive. A good example is the spread of tse-tse fly to the drier regions of northern Nigeria from the southern part. This change also affect the agro-pastoral system as animals have to trek very long distances in search of green grass (De Chavez and Tauli-Corpus, 2008). These movements of the animals also contribute to spread of disease causing organisms and leads to conflict on available resources. The impacts of climate change is not limited to cropping and agro-pastoralism, it is being felt on fisheries and aquaculture (Farauta *et al.,* 2011).

Climate change is another challenge to the initial inability of food production to meet up with the demand which is already identified in Nigeria. Impacts of climate change on the socioeconomic sector are projected to include decline in yield and production, reduced marginal GDP from agriculture, fluctuation in world market price, change in geographical distribution of trade regimes, increased number of people at risk of hunger and food security and migration and civil unrest (Khanal, 2009). Thus, for many poor countries like Nigeria that are highly vulnerable to effects of climate change, understanding farmers' responses to climatic variation is crucial, as this will help in designing appropriate coping strategies (Apata, 2012).

## 2.5 Climate Change Awareness and Perception

Awareness of climate change hasspread at an unprecedented pace and it is now accepted as a major threat to human survivaland sustainable development. The increased adverse impact of climate change is expected onthe environment, human health, food security, economic activities, natural resources andphysical infrastructure(Bako, 2013). Climate change awareness helps farmers to plan their production activities and reduces risks and uncertainties associated with farming (Adebayo *et al,*, 2012).

Social scientists have found that public risk perceptions strongly influence the way people respond to hazards. Public perception is critical because it is a key component of the socio-political context within which policy makers operate. Public perception can fundamentally compel or constrain political, economic and social action to address particular risks (Falaki *et al.,* 2013).

Falaki *et al.*(2013) also identified perception as one factor that had almost been entirely omitted by a majority of researchers in climate change study. They asked how one could adapt to climate change in an adequate way if he did not perceive the current and future climate change as a reality. They asserted that it was reasonable to argue that the first step towards adaptation was the perception of the problem.

Human responses to environmental issues have been broadly categorised as *cognitive* (related to knowledge and understanding), *affective* (related to feelings, attitudes, and emotions), *behavioural* (related to changes in behaviour of the viewer), and *physiological* (biological or physical effects on the observer's body) (Zube *et al.,* 1982). Perception determines the social mental picture of climate change. But a number of other variables like socio-demographic and socio-economic factors or ideological orientations influence perception and the mental picture of climate change (Stedman, 2004; Sjöberg, 1995).

## 2.6 Climate Change Adaptation Practices

Adaptation to climate change refers to adjustment in ecological, social and economic systems in response to the effect of change in climate (Smit *et al*., 2000; Smith and Pilifosova, 2001). It is the adjustment of practices, processes and structures to reduce the negative effects particularly, the unavoidable ones, and takes advantage of any opportunities associated with climate change (IPCC, 2007 cited by FAO, 2008).

Adaption strategies are continuous processes that differ from coping strategies. They are measures used beyond a single season that are needed to respond to a new set of evolving conditions (biophysical, social and economic) not previously experienced while coping strategies evolved over time through people's long experience in dealing with the known and understood natural variation that they expect in seasons combined with their specific responses to the seasons as it unfolds (Dinar *et al.*, 2008).

World Bank (2010) provides a summary of the types of adaptation activities: autonomous (private) and planned (public) adaptation strategies. Autonomous adaptation involvesadaptation action by farmers, communities and others in response to the threats to climate change perceived by them, based on a set of available technology and management options. Food and Agriculture Organization (2007) described autonomous adaptation as the reaction of, for example, a farmer to changing precipitation pattern, in that he/she changes crops or using different harvest and planting (sowing) dates.

Autonomous adaptation is implemented by individuals only when considered cost effective (Mendelsohn, 2006). Potential example of this type of adaptation include selecting different technologies, changing crop inputs, crop management practices suited to new environment, shifting crop calendar and changing irrigation schedule among others.

Planned adaptation involves action by local, regional and/or national government to provide needed public goods and incentives to the private sector to fit the new condition. The conscious policy options or response strategies often multicultural in nature, aimed at altering the adaptive capacity of the agricultural system or facilitating specific adaptations (FAO, 2007). For example deliberate crop selection and distribution strategies across different agro-climatic zones, substitution of new crops for olds ones and resources substitution induced by scarcity (Easterling, 1995).Other examples of planned adaptation include; transport and storage infrastructure, modernization or development of new irrigation infrastructure and training for the private and public sector capacity building (Rosenzweig and Tubiello, 2007).

Farm level analysis has shown that short term adjustments are seen as autonomous in the sense that no other sectors (e.g. policy, research) are needed in their development and implementation. Long term adaptations are major structural changes (planned) to overcome adversity such as changes in land-use to maximize yield under new condition; application of new technologies; new land management techniques; and water use efficiency related techniques (FAO, 2007).

With an explicit focus on real world behaviour, assessments of adaptation practices differ from the more theoretical assessments of potential responses or how such measures might reduce climate damages under hypothetical scenarios of climate change

(Adger *et al.*, 2007). Adaptation practices can be differentiated along several dimensions: by spatial scale (local, regional, national); by sector (water resources, agriculture, tourism, public health, and so on); by type of action (physical, technological, investment, regulatory, market); by actor (national or local government, international donors, private sector, NGOs, local communities and individuals); by climatic zone (dryland, floodplains, mountains, Arctic, and so on); by baseline income/development level of the systems in which they are implemented (least developed countries, middle income countries, and developed countries); or by some combination of these and other categories.

Farmers developed and practiced many adaptation strategies in the tropics peculiar to the impact of climate change in their localities(Mohammed *et al.*, 2014).Several studies reveal that farmers adapt to climate change in order to counter the negative impacts of climate change on their farming activities (Apata *et al.*, 2009; De Jonge, 2010; Deressa *et al.*, 2009; Deressa *et al.*, 2010; Fosu-Mensah *et al.*, 2010; Gbetibouo, 2009; Hassan and Nhemachena, 2007; Hassan and Nhemachena, 2008).

### 2.7 Constraints to Climate Change Adaptation Practices

An adaptation constraint represents a factor or process that makes adaptation planning and implementation more difficult. This could include reductions in the range of adaptation options that can be implemented, increases in the costs of implementation, or reduced efficacy of selected options with respect to achieving adaptation objectives (Klein *et al*., 2014). In this context, a constraint is synonymous with the terms adaptation barrier or obstacle that also appear in the adaptation literature.

However, the existence of a constraint alone does not mean that adaptation is not possible or that one's objectives cannot be achieved. In contrast, an adaptation limit is more restrictive in that it means there are no adaptation options that can be implemented over a given time horizon to achieve one or more management objectives, maintain values, or sustain natural systems. This implies that certain objectives, practices, or livelihoods as well as natural systems may not be sustainable in a changing climate, resulting in deliberate or involuntary system transformations. Individuals have their own perspectives about what are acceptable, tolerable, or intolerable risks, collective judgments about risk are also codified through mechanisms such as engineering design standards, air and water quality standards, and legislation that establishes goals for regulatory action (Klein *et al*., 2014).

Constraints involve limits or barriers to adaptation. Limits are defined here as the conditions or factors that render adaptation ineffective as a response to climate change and are largely insurmountable. These limits are necessarily subjective and dependent upon the values of diverse groups. These limits to adaptation are closely linked to the rate and magnitude of climate change, as well as associated key vulnerabilities (Adger *et al.*, 2007). Adaptation constraints are factors that make it harder to plan and implement adaptation actions (Klein *et al*., 2014).

Adaptation constraints restrict the variety and effectiveness of options for actors to secure their existing objectives, or for a natural system to change in ways that maintain productivity or functioning. These constraints commonly include lack of resources (e.g., funding, technology, or knowledge), institutional characteristics that impede action, or lack of connectivity and environmental quality for ecosystems. The terms "barriers" and "obstacles" are frequently used as synonyms. Constraints—alone or in combination—can drive an actor or natural system to an adaptation limit (Klein *et al.*, (2014). Adaptation limit is the point at which an actor's objectives or system's needs cannot be secured from intolerable risks through adaptive actions (Adger *et al.*, 2009; Moser and Ekstrom, 2010; Dow *et al.*, 2013; Islam *et al.*, 2014).

The perceived limits to adaptation are hence likely to vary according to different metrics. For example, the five numeraires for judging the significance of climate change impacts described by Schneider *et al*. (2000) -monetary loss, loss of life, biodiversity loss, distribution and equity, and quality of life (including factors such as coercion to migrate, conflict over resources, cultural diversity, and loss of cultural heritage sites) -can lead to very different assessments of the limits to adaptation.Adger *et al.*(2007) identified the following limits to climate change adaptation:

### 2.7.1 Physical and ecological limits

There is increasing evidence from ecological studies that the resilience of coupled socio-ecological systems to climate change will depend on the rate and magnitude of climate change, and that there may be critical thresholds beyond which some systems may not be able to adapt to changing climate conditions without radically altering their functional state and system integrity.

Dramatic climatic changes may lead to transformations of the physical environment of a region that limit the possibilities for adaptation (Nicholls and Tol, 2006; Tol *et al.*, 2006). In the Sudano-Sahel region of Africa, persistent below-average rainfall and recurrent droughts in the late 20$^{th}$ century have constricted physical and ecological limits by contributing to land degradation, diminished livelihood opportunities, food insecurity, internal displacement of people, cross-border migrations and civil strife (Mortimore and Adams, 2001; Leary *et al*., 2006; Osman-Elasha *et al*., 2006).

### 2.7.2 Technological limits

Technological adaptations can serve as a potent means of adapting to climate variability and change. New technologies can be developed to adapt to climate change, and the transfer of appropriate technologies to developing countries forms an important component of the United Nations Framework Convention on Climate Change [UNFCCC] (Mace, 2006).

However, there are also potential limits to technology as an adaptation response to climate change. First, technology is developed and applied in a social context, and decision-making under uncertainty may inhibit the adoption or development of technological solutions to climate change adaptation (Tol *et al.,* 2006). Second, although some adaptations may be technologically possible, they may not be economically feasible or culturally desirable. For example, within the context of Africa, large-scale engineering measures for coastal protection are beyond the reach of many governments due to high costs (Ikeme, 2003). Finally, existing or new technology is unlikely to be equally transferable to all contexts and to all groups or individuals, regardless of the extent of country-to-country technology transfers (Baer, 2006).

Adaptations that are effective in one location may be ineffective in other places, or create new vulnerabilities for other places or groups, particularly through negative side effects. For example, although technologies such as snowmobiles and GPS have facilitated adaptation to climate change among some Inuit hunters, these are not equally accessible to all, and they have potentially contributed to inequalities within the community through differential access to resources (Ford *et al.*, 2006).

### 2.7.3 Financial barriers

The implementation of adaptation measures faces a number of financial barriers. At the international level, preliminary estimates from the World Bank indicate that the total costs of 'climate proofing' development could be as high as US$10 billion to US$40 billion /yr (World Bank, 2006). While the analysis notes that such numbers are only rough estimates, the scale of investment implied constitutes a significant financial barrier. At a more local level, individuals and communities can be similarly constrained by the lack of adequate financial resources. In field surveys and focus groups, farmers often cite the lack of adequate financial resources as an important factor that constrains their use of adaptation measures which entail significant investment, such as irrigation systems, improved or new crop varieties, and diversification of farm operations (Smit and Skinner, 2002).

Inadequacy of financial resources may also limit the ability of low-income groups to afford proposed adaptation mechanisms such as climate-risk insurance. Even where both crop insurance and contract farming were being actively promoted by the state and federal government to help farmers address climatic contingencies and price volatility, very few of the surveyed farmers had crop insurance (Wehbe *et al*., 2006). In addition, individuals often fail to purchase insurance against low-probability high-loss events even when it is offered at favourable premiums. While this may occur because of the relative benefits and costs of alternatives, the trade-offs may not be explicit.

Kunreuther *et al*. (2001) show that the search costs involved in collecting and analysing relevant information to clarify trade-offs can be enough to discourage individuals from undertaking such assessments, and thus from purchasing coverage even when the premium is affordable. Climate change is also likely to raise the actuarial uncertainty in catastrophe risk assessment, placing upward pressure on insurance premiums and possibly leading to reductions in risk coverage (Mills, 2005).

### 2.7.4 Information and cognitive barriers

Extensive evidence from psychological research indicates that uncertainty about future climate change combines with individual and social perceptions of risk, opinions and values to influence judgment and decision-making concerning climate change (Oppenheimer and Todorov, 2006). It is increasingly clear that interpretations of danger and risk associated with climate change are context specific (Lorenzoni *et al*., 2005) and that adaptation responses to climate change can be limited by human cognition (Grothmann and Patt, 2005; Moser, 2005).

Four main perspectives on informational and cognitive constraints on individual responses (including adaptation) to climate change emerge from the literature:First, knowledge of climate change causes, impacts and possible solutions does not necessarily lead to adaptation. Well established evidence from the risk, cognitive and behavioural psychology literatures points to the inadequacy of the 'deficit model' of public understanding of science, which assumes that providing individuals with scientifically sound information will result in information assimilation, increased knowledge, action and support for policies based on this information (Eden, 1998; Sturgis and Allum, 2004; Lorenzoni *et al.*, 2005).

Individuals' interpretation of information is mediated by personal and societal values and priorities, personal experience and other contextual factors (Irwin and Wynne, 1996). As a consequence, an individual's awareness and concern either do not necessarily translate into action, or translate into limited action (Baron, 2006; Weber, 2006). This is also known as the 'value-action' or 'attitude-behaviour' gap (Blake, 1999) and has been shown in a small number of studies to be a significant barrier to adaptation action (Patt and Gwata, 2002). Second,perceptions of climate change risks are differing. A small but growing literature addresses the psychological dimensions of evaluating long-term risk; most focuses on behaviour changes in relation to climate change mitigation policies.

However, some studies have explored the behavioural foundations of adaptive responses, including the identification of thresholds, or points at which adaptive behaviour begins (Grothmann and Patt, 2005). Key findings from these studies point to different types of cognitive limits to adaptive responses to climate change. For example, Niemeyer *et al*. (2005) found that thresholds of rapid climate change may induce different individual responses influenced by trust in others (e.g., institutions, collective action, etc.), resulting in adaptive, non-adaptive, and maladaptive behaviours.

Hansen *et al*. (2004) found evidence for a finite pool of worry among farmers in the Argentine Pampas. As concern about one type of risk increases, worry about other risks decreases. Consequently, concerns about violent conflict, disease and hunger, terrorism, and other risks may overshadow considerations about the impacts of climate change and adaptation. This work also indicates, consistently with findings in the wider climate change risk literature (Moser and Dilling, 2004) that individuals tend to prioritise the risks they face, focusing on those they consider – rightly or wrongly – to be the most significant to them at that particular point in time.

Furthermore, a lack of experience of climate-related events may inhibit adequate responses. It has been shown, for instance, that the capacity to adapt among resource-dependent societies in southern Africa is high if based on adaptations to previous changes (Thomas *et al.*, 2005) Although concern about climate change is widespread and high amongst publics in western societies, it is not 'here and now' or a pressing personal priority for most people (Lorenzoni and Pidgeon, 2006).

Weber (2006) found that strong visceral reactions towards the risk of climate change are needed to provoke adaptive behavioural changes.Third,perceptions of vulnerability and adaptive capacity are important. Psychological research, for example, has provided empirical evidence that those who perceive themselves to be vulnerable to environmental risks, or who perceive themselves to be victims of injustice, also perceive themselves to be more at risk from environmental hazards of all types (Satterfield *et al.*, 2004).

Furthermore, perceptions by the vulnerable of barriers to actually adapting do, in fact, limit adaptive actions, even when there are capacities and resources to adapt. Grothman and Patt (2005) examined populations living with flood risk in Germany and farmers dealing with drought risk in Zimbabwe in order to better understand cognitive constraints. They found that action was determined by both perceived abilities to adapt and observable capacities to adapt. They conclude that a divergence between perceived and actual adaptive capacity is a real barrier to adaptive action.

Moser (2005) similarly found that perceived barriers to action are a major constraint in coastal planning for sea-level rise in the United States. Four,appealing to fear and guilt does not motivate appropriate adaptive behaviour. In fact, communications research has shown that appealing to fear and guilt does not succeed in fostering sustained engagement with the issue of climate change (Moser and Dilling, 2004).

Analysis of print media portrayal of climate change demonstrates public confusion when scientific arguments are contrasted in a black-and white, for-and-against manner (Boykoff and Boykoff, 2004; Carvalho and Burgess, 2005; Ereaut and Segnit, 2006). Calls for effective climate-change communication have focused on conveying a consistent, sound message, with the reality of anthropogenic climate change at its core. This, coupled with making climate change personally relevant through messages of practical advice on individual actions, helps to embed responses in people's locality. Visualisation imagery is being increasingly explored as a useful contribution to increasing the effectiveness of communication about climate change risks (Nicholson-Cole, 2005; Sheppard, 2005).

Overall, the psychological research reviewed here indicates that an individual's awareness of an issue, knowledge, personal experience, and a sense of urgency of being personally affected, constitute necessary but insufficient conditions for behaviour or policy change. Perceptions of risk, of vulnerability, motivation and capacity to adapt will also affect behavioural change. These perceptions vary among individuals and groups within populations. Some can act as barriers to adapting to climate change. Policymakers need to be aware of these barriers, provide structural support to overcome them, and concurrently work towards fostering individual empowerment and action.

### 2.7.5 Social and cultural barriers

Social and cultural limits to adaptation can be related to the different ways in which people and groups experience, interpret and respond to climate change. Individuals and groups may have different risk tolerances as well as different preferences about adaptation measures, depending on their worldviews, values and beliefs. Conflicting understandings can impede adaptive actions.

Differential power and access to decision makers may promote adaptive responses by some, while constraining them for others. Thomas and Twyman (2005) analyzed natural-resource policies in southern Africa and showed that even so-called community based interventions to reduce vulnerability create excluded groups without access to decision-making. In addition, diverse understandings and prioritisations of climate change issues across different social and cultural groups can limit adaptive responses (Ford and Smit, 2004).

Most analyses of adaptation propose that successful adaptations involve marginal changes to material circumstances rather than wholesale changes in location and development paths. A few studies have examined the need for and potential for migration, resettlement and relocation as an adaptive strategy, for example, but the cultural implications of large-scale migration are not well understood and could represent significant limits to adaptation. The possibility of migration as a response to climate change is still rarely broached in the literature on adaptation to climate change, perhaps because it is entirely outside the acceptable range of proposals (Orlove, 2005).

Although scientific research indicates that forest ecosystems in northern Canada are among those regions at greatest risk from the impacts of climate change, the social dimensions of forest-dependent communities indicate both a limited community capacity and a limited potential to perceive climate change as a salient risk issue that warrants action. Climate change messages are often associated with environmentalism and environmentalists, who have been perceived by many residents of resource-dependent communities as an oppositional political force. Risk perceptions tend to be higher for women than for men, the higher concern levels of women may either be stifled or simply be unexpressed in a highly male-dominated environment (Davidson *et al.*, 2003).

Anthropological research suggests that the scale and novelty of climate changes are not the sole determinants of degree of impact (Orlove, 2005). Societies change their environments, and thus alter their own vulnerability to climate fluctuations. Accounting for future economic and social trends involves problems of indeterminacy (imperfectly understood structures and processes), discontinuity (novelty and surprise in social systems), reflexivity (the ability of people and organisations to reflect on and adapt their behaviour), and framing (legitimately-diverse views about the state of the world) (Berkhout *et al*., 2002; Pulwarty *et al*., 2003).

Case studies reveal that there exists a diversity of local or traditional practices for ecosystem management under environmental uncertainty. These include rules for social regulation, mechanisms for cultural internalisation of traditional practices and the development of appropriate world views and cultural values (Pretty, 2003). Although many societies are highly adaptive to climate variability and change, vulnerability is dynamic and likely to change in response to multiple processes, including economic globalisation (Leichenko and O’Brien, 2002).

Adaptation to climate change is seldom undertaken in a stand-alone fashion, but as part of broader social and development initiatives. Adaptation also has limits, some posed by the magnitude and rate of climate change, and others that relate to financial, institutional, technological, cultural and cognitive barriers. The capacities for adaptation, and the processes by which it occurs, vary greatly within and across regions, countries, sectors and communities.

Policy and planning processes need to take these aspects into account in the design and implementation of adaptation. High priority should be given to increasing the capacity of countries, regions, communities and social groups to adapt to climate change in ways that are synergistic with wider societal goals of sustainable development. There are significant outstanding research challenges in understanding the processes by which adaptation is occurring and will occur in the future, and in identifying areas for leverage and action by government. Many initiatives on adaptation to climate change are too recent at the time of this assessment to evaluate their impact on reducing societal vulnerability.

## 2.8 Concepts and Measurement of Attitude

Kerlinga (1973) defined an attitude as an organized predisposition to think, feel, perceive and behave toward a referent or cognitive object. It is an individual's characteristic way of responding to situations or objects. Attitudinal behaviour is a certain set of observable behaviour which is preparatory to and indicative of the subsequent actual behaviour. People develop various attitudes towards different phenomena, situations and events (Asika, 2010). Attitude indicates a tendency which can be helpful in predicting the subsequent behaviour.

Individual attitudes to climate change can influence behaviour to adapt to and mitigate climate change. The agricultural community is one sector that has the potential to reduce their greenhouse gas (GHG) emissions through the adoption of a variety of practices, which may also provide individual farmers with significant benefits. As well, the agricultural sector may be heavily affected by future changes in water and temperature, which may require farmers to implement new farming practices to adapt to changing conditions (Niles *et al.*, 2011).

There are several reasons for which measuring of attitudes are very important. Measurement of attitudes is useful in various aspects of day to day life. For instance, it helps in predicting consumer behaviour in making demand forecasts, in providing an insight into the public response to various welfare measures indicated by the government, in maintaining peace and social order and in social research (Anthony, 2003). An attitude measurement survey is a study, on a properly drawn sample, of a specified population to find out what people in that population feel about a specified issue. Attitude surveys usually use carefully constructed, standardised questionnaires (Harvey, 2015).

Attitude scaling is a measurement technique that provides a basis for assigning a numerical value to a person's attitude and for comparing him or her with other people. This is possible when an attitude is conceptualised as measurable on a single scale. Such a scale may be nominal, ordinal or interval, in theory, although most are constructed and used as though they were interval scales (even when they are ordinal) (Harvey, 2015).

There are several established procedures for attitude scaling including the Thurstone, Likert, and Guttman methods (Nnamdi, 1991;Harvey, 2015).

### 2.8.1 Thurstone scale

Thurston scale was the first formal technique for measuring attitudes. It was developed by Thurston in 1928, as a means of measuring attitudes towards religion. It is made up of statement about a particular issue, and each statement has a numerical value indicating how favourable or unfavourable it is judged to be (Aldrich and Luo, 1993).

A Thurstone scale is an attitude scale consisting of items (in the form of statements) with which the respondent has either to agree or disagree. Only those items with which they agree are scored. Each item has a value and the respondent's score on the scale corresponds to the median score of the items with which the respondent agrees. The item scores are usually derived from asking a number of judges to rank each item on the scale using an eleven-point scale reflecting the attitude that is being measured. The final score of each item is the median of the judges' individual scores. Usually, more items are judged than are used and the final selection is based on two criteria: first, items covering the whole eleven-point range are included; second, items should have a small variation (Harvey, 2015).

### 2.8.2 Likert scale

Likert scaling is an attitude scaling method in which respondents indicate the extent of their agreement with each item on a scale (e.g., a five or seven point scale). Their score on the scale is the sum of the scores for each item. Likert scales were devised in 1932 as a improvement of Thurstone scales, the aim was to eliminate the unreliability of using intermediary judges in scale construction.

Original Likert scales had no neutral or middle point and respondents were ‘forced’ to some degree of agreement or disagreement with the scale item. This specification is not enforced by most current users of Likert-type scales (Harvey, 2015). According to Wuensch, (2005) Likert scaling is a bipolar scaling method measuring their positive or negative response to a statement often five ordered response levels, ranging from strongly agreed to strongly disagree are used, although many psychometricians advocate using seven or nine levels.

Likert scales are relatively easy to construct. At the pilot stage, each test item is analysed to see to what extent it contributes consistently to the scale. This can be done by correlating each item score with the overall scale score. Alternatively, the sample can be split into quartiles on the basis of their scale score. The mean score on each item for the upper quartile is compared with the mean score on the same item for the lower quartile. The difference in mean scores for each item is called the discriminatory power of the item. Those with larger discriminatory power are preferable, especially if they have overall item score means approximately equal to the expected mean (i.e., the mean of the possible scores for the item, or mid-point of the range of possible item scores) (Harvey, 2015).

Likert scales may not always be unidimensional but the approach basically assumes a single dimension. It has been argued that analysis of a Likert scale could identify clusters that are indicative of a number of dimensions, although this is much weaker than the multi-dimension identification claimed for Guttman scaling(Harvey, 2015).

The Likert method (like Thurstone and latent structure analysis) involves making inferences about the latent classes into which the manifest data can be made to fit. Unlike the Thurstone scale (where judges have to rationally assess an item's relation to others) Likert scale items can be included that need not be overtly related to the attitude being tested. What is included is determined by the item's correlation with the entire scale score. Thus items that show 'underlying' relationships can be included. For some critics, however, this raises issues of objectivity (Harvey, 2015).

### 2.8.3 Guttmann scale

In the social sciences, the Guttman or "cumulative" scale is one that measures how much of a positive or negative attitude a person has towards a particular topic. It is one of the three major types of unidimensional measurement scales. The other two are the Likert Scale and the Thurstone Scale. A unidimensional measurement scale has only one ("uni") dimension. In other words, it can be represented by a number range, like 0 to 100 lbs or "Depressed from a scale of 1 to 10". By giving the test, a numerical value can be placed on a topic or factor (Horse, 2017).Guttman scale involves the researcher constructing a set of hierarchical statements relating to the concept under investigation. These statements should reflect an increasing intensity of attitude. The point at which the respondent disagrees with a statement reflects the respondent's scale position.

The ideal Guttman scale is such that if the respondent disagrees, for example, with statement 5 (having agreed with statements 1 to 4) then the respondent will disagree with statements 6 and 7 etc. as these represent more extreme expressions of the attitude being investigated. In practice Guttman scales are not perfect. The rank order of the statements may not be interpreted in the same way by the researcher, the subject or by independent judges. Usually, pilot research indicates a coefficient of reliability of the rank ordering (Harvey, 2015).

The strength of the Guttman method is its capacity to identify more than one dimension in the scale. The coefficient of reproducibility is indicative of the extent to which the material relates to a single dimension. Further, the Guttman approach does not make inferences about the latent nature of the data but manipulates the empirical data directly for the determination of an attitude(Harvey, 2015).

## 2.9 Empirical Review of Climate Change Studies

This section reviews the previous findings on climate change. It specifically discusses the findings on climate change awareness of farmers, their climate change perception and climate change adaptation. It also reviews previous findings on the application of Tobit regression and chi-square to the analyses of climate change perception, attitude and use of adaptation practices.

In a study to determine the socio-economic factors influencing climate change adaptation among crop farmers in Umuahia South Area of Abia State, Nigeria, Anyoha *et al.* (2013) found that 92.5% of the farmers were aware of climate change and therefore put up adaptation practices to cope with weather variability. They also determined that 12.5% of the farmers became aware of climate change through the radio, 14.2% were through the television, 5.8% through the newspaper, 25% through extension agents, 14.2% through research institutes, 1.7% through cooperative societies, 3.3% were through the internet, 17.5% got to know about it through their fellow farmers while 5.8% did not indicate their source of the awareness.

In another study to assess farmers' awareness, vulnerability and adaptation to climate change in Adamawa State, Nigeria, Adebayo *et al.* (2012) discovered that majority of the respondents (about 96%) were aware of climate change. They pointed out that awareness of climate change help farmers plan their production activities and reduces risks and uncertainties associated with farming.

Ugwoke *et al.* (2012) reported that the entire (100%) crop farmers in Orlu Agricultural Zone of Imo State, Nigeria were aware of change in climate and that majority (98.33%) observed the change through personal experience. Also a large proportion (48.33%) of the farmers got information on climate change through their various social organizations. Only few of the farmers got information from mass media (31.67%) and extension service (20.00%). They asserted that there was poor information dissemination on climate change through the mass media and extension service to the farmers. This, they said, was buttressed by the fact that none of the farmers seemed to be aware of what caused climate change.

Unfortunately therefore, the farmers may be unconsciously contributing to global warming and climate change through indiscriminate burning of bushes and felling of trees without replacement. They also discovered that majority (75%) of the farmers were aware of changes in rainfall pattern, while many were aware of changes in sunlight (71.67%), temperature (58.33%) and wind (40%).

In a study to determine the farmers perception of impact of climate changes on food crop production in Ogbomosho Agricultural Zone of Oyo State, Nigeria, Ayanwuyi, *et al.* (2010) found that 31.1% of the farmers indicated delayed rainfall, 24.7% indicated higher temperature 11.7% indicated unusual heavy rainfall, 9.4% indicated fast water evaporation and undefined season while 5.0%, 4.4% and 4.2% indicated more longer days than nights, flood with serious consequence and late fruiting of tree crops respectively as the determinant of climate change in their environment.

About 45% of crop farmers in Orlu Agricultural Zone of Imo State, Nigeria perceived climate change “to a large extent” and “to a little extent” (45%) while very few perceived it “to a very large extent” (6.67%) and “to a very little extent” (3.33%) (Ugwoke *et al.,* 2012). Esiobu and Onubuogu (2014) who conducted a trend analysis over 40 years reported that majority (63.33%) of the farmers in Imo State Nigeria perceived an increase in temperature level. The farmers perceived that long-term temperature is increasing significantly, which implies that temperature level has significantly increased over 40 years in the area. They observed that farmers in the area rightly perceived the direction of changes in temperature level implying that they must have been responding to these changes.

Majority (78.33%) of farmers also perceived an increase in rainfall amount over 40 years. The implication of the findings is that rainfall amount has significantly increased over 40 years in the area. Thus, farmers’ perception on changes of climatic variables was in line with the result from the trend analysis conducted. It became clear that farmers in the area rightly perceived the direction of change in rainfall amount implying that they must have been responding to these changes. Esiobu and Onubuogu, (2014),also, found that 65.00% of the farmers in the area observed that relative humidity has decreased over 40 years. This implies that relative humidity has significantly decreased over 40 years in the area. Farmers' perception on changes of climatic variables was in line with the result from the trend analysis. It also became clear that farmers in the area rightly perceived the direction of change in relative humidity implying that they must have been responding to these changes.

Similarly, majority (81.67%) of the farmers in the area observed that sunshine duration has increased over 40 years. This implies that sunshine duration has significantly increased over 40 years in the study area. Farmers' perception on changes of climatic variables was in line with the result from the trend analysis. Farmers in the area rightly perceived the direction of change in sunshine duration implying that they must have been responding to the changes (Esiobu and Onubuogu, 2014).

Idrisa *et al*. (2012) studied the awareness and adaptation strategies to climate change among farmers in the Sahel Savanna zone of Borno State, Nigeria. Result on adaptation strategies practiced by respondents revealed that farmers practiced the use of irrigation to augment shortfall of rains (5.33%), mulching/cover cropping (80.0%), planting deeper than usual (37.78%), and planting ahead of rains (97.78%), intensive manure application (66.67%) and planting crop variety tolerant to climate change (73.33%).

In another study to examine adaptation practices to climate change among rice farmers in Anambra State, Nigeria, Nwalieji and Onwubuya (2012) identified adaptation practices as: use of improved varieties, growing drought resistant crop varieties, growing flood resistant varieties, use of pest/disease resistant varieties, diversification in crop production, use of weather forecast technologies, prayers for God's special intervention, multiple cropping, adoption of minimum/zero tillage, construction of drainage system, use of suitable irrigation system, out-migration from climate risk zones, adoption of recommended improved rice production practices, adjusting the planting calendar, moderate use of agro-chemicals and fertilizers, recycling of waste products and improvement on farmers' management skills.

Anyola *et al*. (2013) examined socio-economic factors influencing climate change adaptation among crop farmers in Umuahia South Area of Abia State, Nigeria and observed that farmers practiced tree planting (13.3%), cultivation of early maturing crop (73.3%), mixed farming (76.7%) and use of improved crop varieties (21.7%). Other adaptation strategies practiced include increased use of family labour (11.7%), diversification of livelihood (1.7%), cover cropping (90%), change in planting and harvesting dates (45%), irrigation practice (2.5%), crop rotation (15.8%) and river side/bank cultivation (7.5%).

Deressa (2010) explored the perception and adaptation to climate change in the Nile Basin of Ethiopia and reported that 58% of the farmers interviewed adapted in one way or the other to climate change. He further observed that the strategies used by the farmers include the use of irrigation (4%), planting of trees (21%), and early and late planting (21%). Other strategies include the use of different crop varieties (13%) the use of soil conservation techniques such as mulching, zero tillage and organic fertilizer application (15%). The use of different crop varieties as adaptation strategy could be associated with the less expensive and ease of access by farmers to new crop varieties that can withstand the new climatic events. However, the limited use of irrigation could be attributed to the needs for more capital and the low potential for irrigation in the region.

Ayanwuyi *et al.* (2010) found that adaptation strategies actually adopted by the farmers in Ogbomosho Agricultural Zone of Oyo State, Nigeria were increase water conservation (68.3%), shading and shelter/mulching (59.4%), soil conservation (55.0%), moving to different site (38.3%), while 34.2%, 20.6% and 19.2% of the farmers implemented water conservation techniques, increased irrigation, and increased or reduction in land size cultivated. They also reported that farmers adopted planting of different crops (74.7%), Treated seeds with fungicides before sowing (60.0%), planted different varieties of crops (58.9%), practised mixed cropping (96.7%) and changed use of chemical (68.9%). Furthermore 54.4% and 52.5% of the farmers adopted change of row orientation with respect to slope and application of soil amendments e.g. farmyard manure, as the strategies to mitigate effect of climate change (Ayanwuyi *et al.*,2010).

Adebayo *et al*. (2012) examined farmers' awareness, vulnerability and adaptation to climate change in Adamawa State, Nigeria. The result shows that about 30% of the farmers use seed tolerant variety, while about 26% alter their planting schedule. Also, about 21% of them plant early maturing seed, about 12% use different tillage system, and about 11% diversify their crops. This study has revealed that farmers adapt different adaptive measures to minimize the effect of climate change in the area. Information from focus group discussion revealed that some farmers have switched over from guinea corn to sweet potatoes due to crop failure arising from early cessation.

Adesina *et al*. (2009) gave some indigenous adaptation strategies to climate variability by farmers, such include; fall back on previous harvest, rainwater harvesting, diversification of livelihood and use of forecasts to prevent responding to a false start of the rains. Other measures adopted by farmers include; planting drought resistant crop varieties, social networking, migration to wetter region and prayer for rain.

Onyekale and Madukwe (2010) explored the adaptation measures by crop farmers in the southeast rainforest zone of Nigeria to climate change and revealed that portfolio diversification was the most commonly used method as reported by 20% of the farmers. This strategy involves the use of improved crop varieties, intercropping and using different crop varieties that survive in adverse conditions. Other strategies used by the farmers include the use of soil conservation techniques (15%), changing planting dates (11.7%) and planting of trees (10%).

Jagtap (1995) identified crop diversification, mixed cropping, using different crop varieties, changing planting and harvesting dates, drought resistant varieties, while Enete *etal*. (2011) also identified multiple/intercropping, agroforestry/afforestation, mulching, purchase/harvest of water for irrigation, among others as some of the climate change adaptation strategies in South-eastern Nigeria.In order to ensure effective adaptation measures, Kuta (2011) suggested that there must be strategic investment, research and development together with local, national and international cooperation to improve agriculture, water management and water storage and saving. Battling desertification requires a well-coordinated, well planned and well-funded approach.

## 2.10 Analytical Framework

Analytical framework discussed the tools of analyzing data for this study. They include Tobit regression and chi square. Findings on the two analytical tools were also discussed.

### 2.10.1 Tobit regression analysis

Tobit regression model was used to establish the effects of some factors on the use of climate change adaptation measures among farmers (Tobin, 1958, Idrisa *et al.*, 2012). The model was used in the study because it measures both the probability of use of adaptation practices and the intensity of use of such practices (Idrisa *et al.*, 2012). The model assumes that use of adaptation practices is a continuous decision. It expresses farmer's use of adaptation practices as a function of linear combination of observable explanatory variables, some unknown parameters, and an error term (e).

The major strength of Tobit model over other econometric models, such as Ordinary Least Square (OLS) for estimation of adoption, is its inclusion of observations with non-use of adaptation practices.Tobit regression has been employed in climate change adaptationstudies by several authors. For instance, in a study to assess the awareness and determine the adaptation to climate change among farmers in the Sahel Savannah Agro-ecological Zone of Borno State, Nigeria, Idrisa *et el.* (2012) used the Tobit regression model to analyze the relationships between some selected socio-economic variables and the use of climate change adaptation measures. They found that level of education, extension visits, age and household size of the respondents were highly significant in influencing the use of adaptation measures among the respondents.

Owodon (2017) used the Tobit regression model to determine the factors that explain the willingness of farmers in Nano - Tandjoare to adopt conservation tillage. He used the method of maximum likelihood for the estimation of the Tobit model. The result showed that farmer's age, ethnicity, awareness of climate change, increase in rainfall length and temperature increase positively affected farmers who were willing to accept payments and renounce the conventional farming system and adopt the new conservation tillage, while education level, family labour availability, hired labour, oil quality and awareness of no-tillage benefits negatively affected farmer's willingness to accept decision.

Fatuase *et al.* (2015) used the Tobit model to examine the determinants of adaptation measures to climate change by arable crop farmers in Owo Local Government Area of Ondo State, Nigeria. They found that household size, education, farm size, income, farming experience and access to extension agents were the factors that statistically and significantly affected the rate of utilizing adaptation measures.

Phiri (2017) applied the translog production and tobit models to examine the impacts of adaptation strategies on food production and food security in low and highland areas of Chikhwawa district, Southern Malawi, respectively. Langyintuo and Mekuria (2008) used a Tobit model to analyse the effects of household characteristics on adoption of improved varieties among Mozambican farmers. The study found a significant contribution of social networks to technology adoption.

### 2.10.2 Chi-square analysis

In a study on impacts and adaptation of climate change in the Niger Delta Region of Nigeria, Nigerian Environmental Study/Action Team (NEST) (2011) reported the use of chi-square statistics to determine if differences exist in the perception of male and female farmers and fisher folks on appropriatenessand timeliness of climate information received on climate change by the respondents. They found no significant difference in the perception of the respondents on the correctness of climate information. They added that the chi-square statistics supported the descriptive statistics which showed most male and female farmers in all agro-ecosystems and States reporting that the climate information they receive is “never correct”.

Kisauzi *et al.* (2012) assessed the gender dimensions of farmers’ perceptions and knowledge on climate change in Teso sub - region, eastern Uganda. They analyzed the farmers’ perceptions on climate change using descriptive statistics (percentages and averages) and used chi-square tests to determine the relationship between farmers’ perceptions and gender. Eleven parameters were used to measure farmers’ perceptions on the climate change. These included farmers’ views on whether; climate change had been generally noticed, temperature had increased, length of seasons had changed, rainfall had decreased; and severity and frequency of drought, floods, winds and storms had increased. They found that the proportion of women who perceived that there was an increase in frequency of droughts was significantly higher than their male counterparts, supporting a significance relationship between perception and gender.

# CHAPTER THREE

# THEORETICAL FRAMEWORK

Theoretical framework is the structure that can hold or support a theory of a research. The theoretical framework is a group of related ideas that provides guidance to a research project. It introduces and describes the theory that explains why the research problem under study exists.

In this chapter, ecological modernization theory, which would serve as a guide for this study would be discussed. The conceptual framework and model for this study would also be discussed.

## 3.1 Ecological Modernization Theory

Ecological modernization is an optimistic school of thought in the social sciences that argues that the economy benefits from moves towards environmentalism. It has gained increasing attention among scholars and policymakers in the last several decades internationally. It is an analytical approach as well as a policy strategy and environmental discourse (Hajer, 1995).

Ecological modernization theory states that contemporary economic practices are firmly rooted in modernity, and are related to modern scientific technological and state institutions (Mol, 1996). The theory emerged in the early 1980s within a group of scholars at free University and the Social Science Research Centre in Berlin. Among the proponents were Joseph Huber, Martin Janicke and Udo E. Simons (Mol and Sonnenfeld, 2000; Mol, 2001).

The theory grew largely out of a necessity, with an assumption relating to environmental re-adoption of economic growth and industrial development. Giving environmental policy the chance to claim its position in the day-to-day process of environmental politics and environmental policy making, against the background of past failures and a higher priority in industrialized societies to the goals of economic success, a new conceptualization was needed (Hajer, 1995).

Ecological modernization is a theory of evolutional social change, which sees an ecological version of modernization emerging in the present period, which marries continuing technological and economic development with environmental solutions. In other words, policies for economic development and environmental protection can be combined to synergistic effects, creating a positive-sum game between economy and ecology. Rather than seeing environmental protection as a brake on growth, ecological modernization promotes the application of stringent environmental policy as a positive influence on economic efficiency and technological innovation (Gouldson and Murphy, 1997). This means that economic growth and the resolution of ecological problems can, in principle, be reconciled (Hajer, 1996).

Four key features were identified to distinguish ecological modernization from other theoretical approaches (Christoff, 1996; Mol, 1996).These are technological adjustment, belief system, policy discourse and environmental policy making.Ecological modernization is concerned with technological developments with environmentally beneficial outcomes. These outcomes are specifically aimed at reducing emissions at source and fostering greater resource efficiency. Ecological modernization is primarily a strategy intended to maintain or improve market competitiveness, in which the environmental benefits of technological change are related to companies' cost minimizing responses to new pressures from the market itself and broader society (Christoff, 1996).

The concept of ecological modernization reflects an ideology based on the understanding that environmental protection is a precondition of long-term economic development. It emphasizes the achievement of the highest possible environmental standards as a means for developing market advantage through the integration of anticipatory mechanisms into the production process, the recognition of actual and anticipated costs of environmental externalities in economic planning, and the economic importance of strengthening consumer preferences for cleaner or 'green' products (Weale, 1992; Christoff, 1996).

Internalizing care for the environment into existing patterns of economic production and consumption or, in other words, facilitating change in environmental policy within the broad framework of modernity, also determines the discourse about the environment. So far, this discourse has been largely economistic-framing environmental problems in monetary terms, portraying environmental protection as a matter of good management and potential cost savings.

At the core of ecological modernization is the idea that 'pollution prevention pays', thus it is essentially an efficiency-oriented approach to the environment (Christoff, 1996). Hajer (1995) argued that ecological modernization uses the language of business and conceptualizes environmental pollution as a matter of inefficiency, while operating within the boundaries of cost-effectiveness and administrative efficiency.

One of the most important aspects in analysing the theory of ecological modernization is how it relates to the process of environmental policy making. What policies are formulated within the discourse of ecological modernization? Which societal actors play an important role in the formulation and implementation of those policies? First, ecological modernization favours a style of environmental policy making within which nation-state intervention moves away from a mere hierarchical command and control policy-style and towards a more decentralized policy-style, consensual negotiations, partial self-regulation (with legal boundaries), and the use of market mechanisms and instruments (Berger, 1999; Mol, 1999).

Second, the changing state–market relations result in an increasing activation of economic agents and mechanisms for environmental reform. Producers, consumers/customers, and suppliers appear as actors for environmental reform, using mainly economic arguments and mechanisms to articulate environmental goals. One has to make clear that most of those actors do not embrace the environmental agenda from an altruistic perspective, but are influenced or driven by tight state legislation, environmental awareness and protest, and changing economic cost–benefit relations (Mol, 1999). Transnationalization and globalization change the social dynamics behind environmental reforms. The nation-state is no longer the only level of analysing and influencing environmental policy making (Mol, 1999).

### 3.1.1 Relevance of ecological modernization theory

In social science research, ecological modernization represents a body of work that devices small-scale, practical solutions to environmental problems with a view to rolling out solutions that work. It focuses on technological innovation and the use of market mechanisms to bring about positive outcomes, transforming production methods and reducing pollution at its source (Giddens, 2009). Glasson (2012) observed that ecological modernization transforms the threat of climate change into an opportunity, a new motor of neoliberal legitimacy. The historic bloc has co-opted environmentalist discourse to promote a gentrified climate change which present institutions are capable of managing.

Ecological modernization theory is relevant to this study, since it emphasizes on environmental protection, economic growth and resolution of ecological problems which are important to this study. Understanding the ecological modernization theory will, therefore, guide the analysis of the factors influencing climate change adaptation practices among rice farmers in Kebbi, Sokoto and Zamfara States, Nigeria.

### 3.1.2 Criticisms of ecological modernization theory

Many scholars are very critical about the theoretical assumptions of ecological modernization. Among them are Connelly and Smith (1999) who see ecological modernization basically as a form of 'green capitalism'. They argue that ecological modernization justifies the status quo and Western-style industrialization by hindering more radical environmental positions from coming forward and by not fully exploiting the radical potential of the concept of sustainable development.

They pointed out that ecological modernization reinforces a technocentric worldview. They think, however, that working towards sustainability calls for a reinterpretation of needs. Quality of life, identified by them as a basic principle of the whole sustainability concept, would go beyond simple measures of economic wealth: 'It also requires strong control of markets in order to safeguard the environment and intra-and intergenerational obligations' (Connelly and Smith, 1999; Berger *et al.,* 2001).

The most comprehensive critique of the theory of ecological modernization was undertaken by Christoff (1996) who distinguished between 'weak' and 'strong' versions of ecological modernization, according to their likely efficacy in promoting enduring ecologically sustainable transformations and outcomes across a range of issues and institutions. He argued that within the 'weak' version of ecological modernization, the environment is reduced to concerns about resource management and inputs, waste management, energy efficiency and pollutant emissions.

Talking this business language implies that the environment is measured in monetary terms, i.e. as financial cost savings that can be gained from environmental management. As broader social and cultural needs and non-anthropocentric values cannot be reduced to monetary terms, they are largely excluded from the theory of ecological modernization. Furthermore, 'weak' ecological modernization is focused mainly on policy processes and changes within industrialized nation-states (Christoff, 1996; Berger *et al.*, 2001).

Gibbs (2000) also points out, that ecological modernization has ignored the sub-national level. However, there appears to be a strong rationale for including the regional and local level into environmental analyses, considering the prominence given to this level in international documents (United Nation's Agenda 21, and the European Union's Fifth Environmental Action Programme), and the role of regional governance in regional economic policy making (e.g. the regional development agencies in the United Kingdom).

Christoff (1996) makes the criticism that ‘weak’ ecological modernization presents a unilinear path to ecological modernity. This suggests that this version of ecological modernization is in favour of mainstream development theory, identifying it as the next necessary stage of an evolutionary process of industrial transformation. This stage is characterized by, and dependent on, the hegemony of Western science, technology and consumer culture (Berger *et al.,* 2001).

Christoff (1996) further pointed out that ‘weak’ ecological modernization is characterized by a technocratic and neo-corporatist style, including mainly politicians and representatives from the industrial sector - e.g. with the policy instrument of voluntary agreements (Berger, 1999) - leaving out large parts of the population. This may prove primarily a rhetorical device seeking to manage radical dissent and secure the legitimacy of existing policy while delivering limited, economically acceptable environmental improvements.

**3.2 Conceptual Framework**

A conceptual framework is the researcher’s synthesis of literature on how to explain the research concepts. This study is based on the concepts of climate change andclimate change adaptation.

### 3.2.1 Concept of climate change

Climate change is defined as statistically significant variations in climatic condition that persists for an extended period, typically for decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the Framework Convention on Climate Change, where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods (IPCC, 2001; IPCC, 2007).

Climate change is largely attributed to anthropogenic greenhouse gas emission. Greenhouse gas emissions are continuing to increase in both developed and developing countries, but more rapidly in major developing countries [Participatory Ecological Land Use Management (PELUM), 2010]It is a process of global warming, in part attributable to the 'greenhouse gases' generated by human activity (Farauta *et al.*, 2011). Agriculture is a major source of global greenhouse emissions, representing 10-12% of total global anthropogenic emissions of greenhouse gases (GHGs) (Wreford, *et al.*, 2010;OECD, 2012).

There are two central ideas for dealing with climate change, namely, mitigation and adaptation. Mitigation is a response strategy to global climate change, and can be explained as measures that reduce the amount of emissions (abatement) or enhance the absorption capacity of greenhouse gases (sequestration). It refers to the reduction of climate change through reduced emissions of GHGs. Mitigation will take time as it is a long time measure and so adaptation becomes a short-term and immediate response to the effects of climate change.

The Kyoto Protocol governs the countries' reductions in the greenhouse gas emissions but these reductions will not lead to direct stabilisation due to time lags offering adaptation as the best option to respond to climate change (Mudzonga, 2012). Adaptation to climate change is an adjustment made to human, ecological or physical system in response to vulnerability (Adger *et al.*, 2007). Climate change adaptation through the modification or improvement of agricultural practices will be imperative to continue meeting the growing food demands of modern society (Rosegrant *et al.*, 2008).

The climate is changing and mitigation efforts to reduce sources or enhance the sinks of greenhouse gases will take time. Adaptation is therefore critical and of concern in developing countries, particularly Africa (including Nigeria) where vulnerability is high because the ability to adapt is low. Climate change is expected to affect food and water resources critical to livelihood in Africa and much of the population, especially the poor, rely on local supply systems that are sensitive to climate variations. Disruptions of the existing food and water systems will have devastating implications for development and livelihoods and are expected to add to the challenge already posed by climate change for poverty eradication (De Wit & Stankiewcz, 2006; International Institute of Sustainable Development [IISD], 2007).

Climate change can have positive consequences. It will bring opportunity – positive changes are likely to occur somewhere, sometime - but flexibility and responsiveness will be needed to realise potential benefits (Howden *et al.*, 2007). Preparing for climate-related changes will not only mean preparing for the worst; in some cases it may also mean preparing to take advantage of new conditions (Fankhauser *et al.*, 1999; Fenton*et al.*, 2007; Johnson and Marshall, 2007). For example, in some regions, climate change experts are predicting that higher rainfall can be expected, which could open up new and profitable agriculture opportunities. Coastal communities and industries that are resilient to climate change will be able to both minimise the social and economic impacts, and maximise the potential associated opportunities.

The impacts of climate change are being felt by both developed and developing countries. These impacts are likely to be felt more by developing countries not necessarily because they are the highest contributors to climate variations but because they lack economic, social and political infrastructures to respond adequately to the effects of climate change. Climate change impacts are felt on agricultural production, health, biodiversity, social and economic conditions and affect people and the environment in general. Climate change is predicted to worsen the incidence of drought and desertification and millions of people will become refugees as a result.

The 2005 FAO Global Forest Resources Assessment showed that forest and woodland in sub Saharan Africa presently cover about 530 million ha, compared to 710 million ha in 1975. This ongoing degradation of natural resources is reducing the resilience of the agro-ecosystems to drought, further undermining the region's future capacity to cope with climate change (Anuforom, 2009). According to the World Health Organization (2004) skin eruptions, heat fatigue, heat cramps, heat syncope, heat exhaustion and heat stroke are classical heat related illnesses which are resultant from climate change variations.

Climate change has led to a reduction in livelihood options in many ACP countries. Migration within rural communities as a response to the impact of climate change on the productivity of local resources, have left many households without young and able bodied labour(Farauta *et al.,* 2011). De Chavez and Tauli-Corpus (2008) asserted that climate change results to socioeconomic impacts in loss of revenue, economic opportunities and the practice of traditional culture which are expected to increase the social and cultural pressures on indigenous people. The out migration of indigenous youths to seek for economic opportunities elsewhere because of climate change has further limited opportunities in their own communities; this could lead to erosions of indigenous economies and culture.

### 3.2.2 Concept of climate change adaptation

Adaptation to climate change is action that minimizes the consequences of actual and expected changes in the climate (Parliamentary Office of Science and Technology (POST, 2006). Adaptation refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2007). According to Burton *et al* (1998) adaptation to climate is the process through which people reduce the adverse effects of climate on their health and well-being and take advantage of the opportunities that their climatic environment provides.

Downing *et al.* (1997) asserted that adaptation is synonymous with "downstream coping". Füssel and Klein (2002) defined it as all changes in a system, compared to a reference case that reduces the adverse effects of climate change. Intergovernmental Panel on Climate Change (2001) defines adaptation to climate change as adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. This term refers to changes in processes, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate. It involves adjustments to reduce the vulnerability of communities, regions, or activities to climatic change and variability. It involves adjustments to enhance the viability of social and economic activities and to reduce their vulnerability to climate, including its current variability and extreme events as well as longer term climate change (Smith, 2000).

Adaptation options can be seen as interventions put in place in order to manage the losses or take advantage of the opportunities presented by climate change. The distinction among livelihood option, coping options and adaptation options is not too clear in literature, they are often used inter-changeably (Odozi, 2014).

From a temporal perspective, adaptation to climate risks can be viewed at three levels, including responses to: current variability (which also reflect learning from past adaptations to historical climates); observed medium and long-term trends in climate; and anticipatory planning in response to model-based scenarios of long-term climate change. The responses across the three levels are often intertwined, and indeed might form a continuum. Adapting to current climate variability is already sensible in an economic development context, given the direct and certain evidence of the adverse impacts of such phenomena (Goklany, 1995; Smit *et al.*, 2001; Agrawala and Cane, 2002).

Therefore, poverty eradication programmes must be pursued with vigour at all levels of government aimed at empowering people particularly the peasant farmers, to increase their ability to cope with the challenges of climate change. There is also the need to build the adaptive capacity of our local farmers and fishermen who depend on agriculture as the only source of food and source of income. There must be an effective sensitization programme to bring this awareness to the people. Schools are expected to establish climate change clubs, development of manuals for training and enlightenment on climate change using local languages to ensure grassroots mobilization.

Adaptation helps farmers achieve their food, income and livelihood security objectives in the face of changing climatic and socioeconomic conditions, including volatile short-term changes in local and large-scale markets (Kandlinkar & Risbey, 2000).

**3.3 Conceptual Model**

A model is a general conception of a phenomenon. The conceptual model for this study is represented by a diagram that shows the relationship between the independent variables (socioeconomic, institutional and technical factors) and the dependent variable (use of adaptation strategies to climate change mitigation) (Figure 1). The independent variables are expected to have influence on the dependent variable with expected outcomes indicated as likely effects. For instance, education is expected to have a positive effect on the choice of adaptation practices to mitigate climate change.

Similarly, access to credit can, also, have a positive effect on the use of the adaptation strategies by the farmers due to the financial implication of the use of the adaptation strategies. Such relationships can lead to expected outcomes or likely outcomes such as changes in rice yield, output,income and farmers' level of living.These are known as effect variables.

**Independent Variables**

**Socioeconomic factors**

i. Age
ii. Sex
iii. Marital status
iv. Household size
v. Years of formal Education
vi. Faming experience
vii. Farm size
viii. Off-farm employment
ix. Rice income
x. Climate change awareness
xi. Access to weather information
xii. Farmers' attitude

**Institutional factors**

i. Amount accessed as credit
ii. Extension contact
iii. Cooperative membership

**Attributes of climate change adaptation practices**

i. Affordability
ii. Complexity
iii. Relative advantage

→

**Dependent Variable**

**Use of climate changeadaptation practices:**

1) Portfolio Diversification:
   i. Use of improved rice varieties
   ii. Intercropping.
2) Soil Conservation:
   i. Mulching
   ii. Planting of cover crops
   iii. Planting of trees
   iv. Moderate use of fertilizers
   v. Moderate use of chemicals
   vi. Use of organic manure.
3) Adjusting the planting calendar
   i. Early planting
   ii. Late planting
   iii. Late harvesting
   iv. Early harvesting
4) Use of minimum tillage
   i. Zero tillage
   ii. Making mounds and ridges across slopes
5) Use of irrigation technologies
   i. Rainwater harvesting
   ii. Use of river/stream
   iii. Digging of well
   iv. Sinking of bore-hole

→

**Observable**

i. Change in rice output
ii. Change in rice yield
iii. Change in income from rice
iv. Change in level of living

**Figure 3.1: A model of factors influencing the use of climate changeadaptationpractices and observable outcomes among rice farmers**

# CHAPTER FOUR

# METHODOLOGY

## 4.5 The Study Area

The study was conducted in three States namely: Kebbi, Sokoto and Zamfara of North-West zone, Nigeria. The zone, located between latitude $9^{0}10^{1}$N and $13^{0}50^{1}$N and longitude $3^{0}35^{1}$E and $9^{0}00^{1}$E, (Figure 4.1) covers about 168, 719 km$^{2}$. It consists of Jigawa, Kaduna, Kano, Kebbi, Sokoto and Zamfara States. It leads the other zones in terms of population with a projected population of 46,694,805 million people (National Population Commission (NPC), 2015). It is located between latitude $10^{0}05^{1}$N and $13^{0}50^{1}$N and longitude $03^{0}35^{1}$E and $07^{0}13^{1}$E. They covered a total land of about 102, 535 km$^{2}$ (Table 4.1).

The zone's vegetation consists of Northern Guinea Savannah and Sudan Savannah, a vegetation belt covering most parts of the zone stretching from the Sokoto plains in the west, through the northern sections of the central highland. The low annual rainfall of usually less than 1000mm and the prolonged dry season (6-9 months) sustain fewer trees and shorter grasses than the Southern Guinea Savannah. It is characterized by abundant short grasses of about 1.5-2m and few stunted trees hardly above 15m. It is by far the most densely human populated zone of northern Nigeria. Thus, the vegetation has undergone a severe destruction in the process of clearing land for the cultivation of important economic crops such as cotton, millet, maize and wheat. This is in addition to the devastation due to animal husbandry, especially cattle rearing, which is greatly favoured in this belt because the area is relatively free from tse-tse fly. The trees of the Sudan Savannah include the acacia, the shea-butter, baobab and the silk cotton (Online Nigeria, 2002).

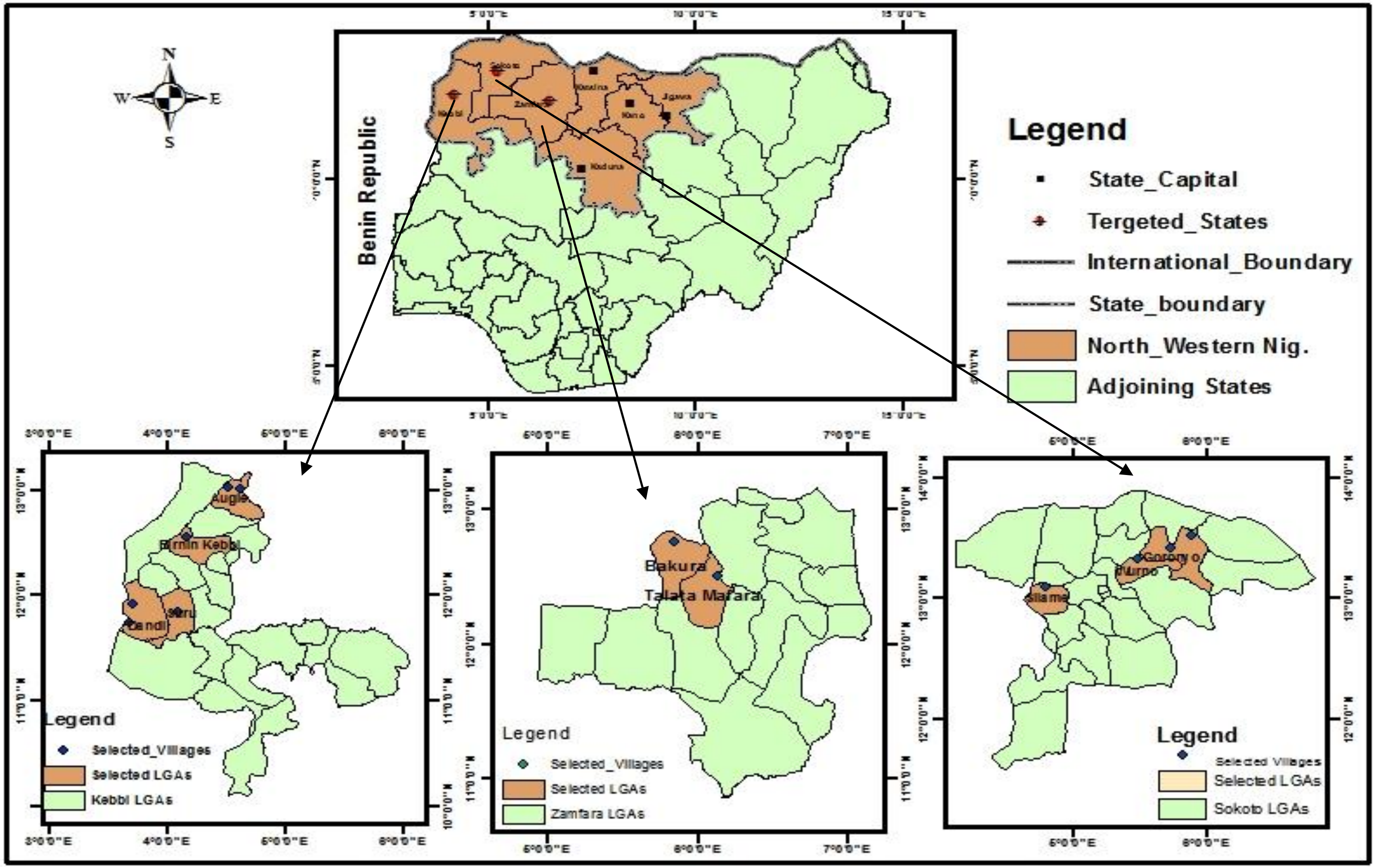


**Figure 4.1: Map of the study area**

According to the United States Agency for International Development (USAID) (2007)North-West zone, Nigeria represents the manipulation of river water on large and small scales. The decades-old irrigation schemes, based mainly on the Rima-Sokoto complex, dominate the northern half of Sokoto State, extending upriver into the northwest of Zamfara State and downriver far into northern Kebbi State. Although rice comes first, both as a staple and a cash crop, a variety of other crops are grown in upland farms as well as the irrigated areas. Rainy season is for cultivation of upland farm centres on millet, sorghum, and cowpeas, while vegetables are an important product of the irrigated soils (or soils retaining residual moisture) in the cooler dry season months.

Northwest zone has a very general mix of food and cash crops, stretching across Sokoto, Kebbi, Zamfara, Katsina, Kano, and Jigawa states, with associated husbandry of sheep, goats, and cattle. The zone represents the transition from emphasis on sorghum to maize, together with some upland rice. Maize production increased in response to market demand, which translated to favourable prices as a cash crop as well as use as a staple. But recently, the maize market has been adversely affected by the bird flu outbreaks, as maize is the staple of the poultry industry. This may herald a short-term or longer-term shift in production away from maize and towards products with more stability in market demand such as rice (USAID, 2007).In terms of rice production in Nigeria, the North-West was second in 2013, after the North-Central, with production of 1,294,200 Metric Tonnes which was 28.6% of the country's total(Rapu, 2016).

### 4.5.1 Kebbi State

Kebbi State, which was curved out of the old Sokoto State, is located within latitude $10^{0}05^{1}$N and $13^{0}27^{1}$N and Longitudes $3^{0}35^{1}$E and $6^{0}03^{1}$E. It shares international borders with Niger Republic in the West and Benin Republic in the South. It also shares a common boundary with Sokoto State in the western and southern parts. It is located in the Semi-arid Sudano-Sahelian ecological zone and experiences serious moisture deficiency for greater part of the year (Singh, 1995). However, the Southern portion of the State falls within Northern Guinea Savannah Ecological Zone.

Generally, the State is characterized by high temperatures especially in the months of March, April and May. The annual temperature varies from $21^oC$ – $38^oC$ (Table 4.1). The soil type found in the state ranges from heavy clay in the *fadama* areas to sandy loam and sandy soil in the upland areas [Kebbi Agricultural and Rural Development Authority (KARDA), 1992]. Rainfall in Kebbi State begins around April and ends in October with highest rain in July and August. The annual rainfall ranges from 500 to 850mm increasing both in quantity and intensity within the State from the north to the south (Singh, 1995).

Kebbi State has a projected population of 4,279,777 people (NPC, 2015). Among the major ethnic groups found in the area are Hausa, Fulani, Dakarkari, and Zabarmawa. Others include Gungawa, Dandawa and Kambari. Majority of the inhabitants of the State are peasant farmers who reside in rural settlements, particularly along the bank of the existing rivers. Upland crops produced include millet, sorghum, rice, cowpea and maize, while the vegetable crops include tomato, pepper, onions, okra, lettuce, carrots etc. Other occupations in the area include fishing and livestock rearing (Kebbi State Diary, 2008).

The State has a network of rivers consisting of Rivers Niger, Rima, Zamfara and Ka and their tributaries. River Niger and River Rima traverse a distance of about 190km within the State. The *fadama* along the flood plains of these rivers are intensively cultivated (both rain fed and irrigated).

River and lake fishing is a minor activity in many locations around the whole of northern Nigeria. But in the Northwest region, Kebbi State has three areas where fishing is a dominant activity, with rice and dryland cereals cultivation alongside. The areas are on the tributary to the Sokoto River in Arewa-Dandi LGA, on the Ka River in Danko/Wasagu LGA in far southeast Kebbi State, and on the Niger River in Yauri LGA in southern Kebbi State.A narrower, river-bound rice irrigation economy defines another zone through southern Kebbi State: Along the Niger River, as it enters Nigeria and feeds the great Kainji Lake/reservoir before descending into Niger State and its floodplain area(United States Agency for International Development (USAID), 2007).

### 4.5.2 Sokoto State

Sokoto State is located to the extreme north western part of Nigeria. It is geographically located between latitude $11^{0}30^{1}$N and $13^{0}50^{1}$N and longitude $4^{0}00^{1}$E and $6^{0}04^{1}$E. It shares common border with Niger Republic to the north, Kebbi State to the south west, and Zamfara to the east (Mamman *et al.,* 2000).

The State covers a total land area of approximately 102,540 square kilometers. It has a projected population of 4,841,822 people (NPC, 2015). The two main ethnic groups are; Hausa and Fulani. Over 80% of the population of the State practice one form of agriculture or the other. The crops produced are millet, guinea corn, maize, rice, potatoes, cassava, groundnut, and beans for food and wheat, cotton and vegetable for cash. Local crafts such as blacksmithing, weaving, dyeing, carving and leather works also play an important role in economic life of the people [Millennium Development Goals (MDGs), 2006].

Sokoto State falls in the Sudan savannah agro ecology. The climate is tropical continental and is dominated by two opposing air masses, tropical continental and tropical maritime.  The

State has an annual temperature range of 23-43$^{o}$C. Much of the rain falls between June and September in the northern parts and April and October in the other parts. The annual rainfall is between 400mm in the north and 750mm (Table 4.1).The dry season starts from October and lasts up to April in some parts and extends to May or June in other parts of the State. Harmattan is experienced in the State between November and February each year (Mamman *et al*., 2000). The region's lifeline for growing crops is the floodplains of the Sokoto and Rima river system, which are covered with rich alluvial soils.

As the need for irrigated crop such as rice cultivation grew in the country between 1972 and 1974, Bakolori irrigation scheme, in Sokoto State, along with others (Kano river irrigation scheme and the Chad Basin scheme) were developed (NINCID, 2015). Sokoto-Rima River Basin Development Authority (SRBDA) was established in mitigating the adverse effect of the early 1970s drought by the Nigerian government(Ugalahi*et al*, 2016).

### 4.5.3 Zamfara State

Zamfara State was created on the 1st October, 1996. Located from latitudes $10^{0}50^{1}$N and $13^{0}38^{1}$N and longitude $4^{0}16^{1}$E and $7^{0}13^{1}$E, it covers a landmass of 39, 762 square kilometres(Table 4.1). It shares boundaries with Niger, and Kebbi States in the West, Katsina State in the east, Kaduna State in the south and Sokoto State and Niger Republic in the north (Zamfara Handbook, 2007).. It has a projected population of 4,330,725 people (NPC, 2015).

The vegetation is primarily covered by a hybrid of Southern, Sudan and Northern Guinea Savannah which consist of grasses, bushes and trees. The area has two marked periods of dry season (including Harmattan) November to April and Rainy season from May to October. The State has an annual temperature range of 25-42$^{o}$C.The Annual Rainfall Range is 550-900mm (Zamfara Handbook, 2007).

It can be further established that agriculture is the back bone of the State economy. Crops grown mostly in the area are millet, sorghum, maize, rice, cowpea and wheat (Zamfara Handbook, 2007). Agriculture has a unique position in the economy of the state. It is estimated that agriculture, in its various forms, provides the means of livelihood to over 80 per cent of the population of the area. In addition to crop production, the inhabitants of Zamfara State engage in rearing of livestock such as cattle, sheep, goats and poultry. It is estimated that the livestock population in the area is well over 9 million heads (Dangusau, 1998).River Zamfara, one of the country's perennial rivers drained mainly by the River Niger (Goldface-Irokalibe, 2008) is an important source of irrigation water for rice production.

**Table 4.1: Land size, population and location of the study area**

| **State** | **Land Size ($km^2$)** | **Population** | **Latitude** | **Longitude** | **No of LGAs** | **ARR (mm)*** | **ATR ($^oC$) **** |
|---|---|---|---|---|---|---|---|
| Kebbi | 36,800 | 4,279,777 | $10^{0}05^{1}$N and $13^{0}27^{1}$N | $3^{0}35^{1}$E and $6^{0}03^{1}$E | 21 | 500-850 | 21-38 |
| Sokoto | 25,973 | 4,841,822 | $11^{0}30^{1}$N and $13^{0}50^{1}$N | $4^{0}00^{1}$E and $6^{0}04^{1}$E | 23 | 400-750 | 23-43 |
| Zamfara | 39,762 | 4,330,725 | $10^{0}50^{1}$N and $13^{0}38^{1}$N | $4^{0}16^{1}$E and $7^{0}13^{1}$E | 14 | 550-900 | 25-42 |

*** ARR:** Annual Rainfall Range; **** ATR:** Annual Temperature Range.

### 4.6 Sampling Procedure and Sample Size

This study targeted Sokoto, Kebbi and Zamfara States in the North-West, Nigeria. They are among the major rice producing States in the country and the region in particular.A multistage sampling procedure was used to obtain the sample. In the first stage, 4,out of the20 major rice producing LGAs,were purposively selected in Kebbi State (based on high population of the rice farmers);3 out of 14 LGAs in Sokoto and 2 out of 12 LGAs in Zamfara States. This gave 9 out of 46 LGAs (20%) in the 3 States. The LGAs chosen from Kebbi

State included Augie, Dandi, Birnin Kebbi and Suru. Those from Sokoto State included Goronyo, Wurno and Silame. From Zamfara State, Bakura and Talata MafaraLGAswere selected.

The second stage was a purposive selection of 16 villages out of 286 (5%), also based on high population of the rice farmers, from the villages. In the third stage 522 farmers (2.873%) out of 17,071 (sampling frame) were randomly chosen from the selected villages to give the study sample (Table 4.2).

**Table 4.2:Sampling procedure and sample size**

| State | Number of Major rice producing LGAs | Selected LGAs (20%) | Number of Major rice producing villages | Selected villages (5%) | Number of rice farmers (sampling frame)* | Selected rice farmers (3%) (sample) |
|---|---|---|---|---|---|---|
| Kebbi | 20 | Augie | 73 | Augie | 1079 | 31 |
| | | | | Yola | 706 | 22 |
| | | | | Rayau | 453 | 13 |
| | | | | G/dabi | 383 | 11 |
| | | Dandi | 40 | Kamba | 1532 | 44 |
| | | | | Dolekaina | 597 | 16 |
| | | B/Kebbi | 27 | B/Kebbi | 2088 | 60 |
| | | Suru | 51 | Suru | 1532 | 44 |
| | | | | Takalafiya | 801 | 23 |
| | | | | Giro | 522 | 15 |
| Sokoto | 14 | Goronyo | 42 | Takakume | 3446 | 99 |
| | | | | Birjingo | 940 | 27 |
| | | Wurno | 13 | Wurno | 835 | 24 |
| | | Silame | 15 | Katami | 1287 | 37 |
| Zamfara | 12 | Bakura | 13 | Yar Kofoji | 835 | 24 |
| | | T/Mafara | 12 | T/Mafara | 1114 | 32 |
| **TOTAL** | **46** | **9** | **286** | **16** | **17071** | **522** |

Source: Reconnaissance survey, 2014 *Obtained from the States' Rice farmers Association and ADPs

## 4.7 Method and Sources of Data Collection

Primary data for this study were obtained with the aid of structured questionnaire administered by trained enumerators. The enumerators consisted of States' ADPs and some LGAs Department of Agriculture staff. They were trained by the researcher, assisted by some senior staff of the ADPs at the ADPs' headquarters of the three States (Kebbi, Sokoto and Zamfara). The data, involving information on 2015 farming season, were collected from August, 2016 to January, 2017.

The dataconsist of information on the farmers' socioeconomic characteristics including age, sex, household size, level of education, farm size, farming experience, off-farm employment, level of rice income and weather information. Information on institutional factors such as access to credit, extension contact and membership of associations will be obtained. Similarly, factors related to attributes of technologies namely; affordability, complexity and relative advantage were also obtained. They also contained information on farmers' perceived effects of climate change on rice production, climate change adaptation practices employed by the farmers, farmers' attitude to use of climate change adaptation practices and constraints to use of climate change adaptation practices by the farmers.

**4.8 Analytical Techniques**

Data for this study were analyzed using both descriptive and inferential statistics.

**4.8.1 Descriptive statistics**

Descriptive statistics such as frequency counts, percentages, ranges and means were used to achieve objectives:(i) and (ii), which described the socioeconomic characteristics of rice farmers and identified the level of awareness of the effects of climate change by the farmers; (iii), which identifiedand described the climate change adaptation practices employed by rice farmers in the area and (viii), which identifiedand described the constraints to use of climate change adaptation practices by the farmers.

Likert scale was used to measure the farmers' attitude to use of climate change adaptation practices (objective vi). Likert scale consists of statements about attitudinal objectives. The farmers were required to indicate the degree to which they agree or disagree with each statement. The result was used to measure the level of the farmers' agreement to examine their attitude to use of climate change adaptation practices in the study area. Different statements on the use of climate change adaptation practices were subjected to a 5-point Likert items where strongly disagree = 1, disagree = 2, undecided = 3, agree =4 and strongly agree = 5. The mid-point is 3.0 (1+2+3+4+5 = 15/5). Therefore any score below 3.0 indicates an unfavourable attitude on the use of climate change adaptation practices by the farmers, while 3.0 and above is a positive attitude which may favour the use of climate change adaptation practices.

### 4.8.2 Inferential Statistics

Chi-square and Tobit regression analysis were the inferential statistics used.

***Chi-square test***

Chi-square was used to achieve objectives(iv), which assessed the perceived effects ofclimate change on rice production among the farmers and objectives (v) and (vi), which determined the effect rice farmers' use of climate change adaptation practices on their level of livingand examined the farmers' attitude to use of climate change adaptation practices, respectively. Perception of the farmers on the effects of climate change on rice production was captured using scores: 0= no effect, 1= low effect and 2=higheffect. Rice yield was also categorized into low = 1, medium = 2 and high = 3. Attitude was captured using 5-point Likert items as described earlier.Hence, the relationship between the farmers' perception and rice productionas well as the relationships between farmers' attitude to use of climate change adaptation practices and use of the practices were measured using the chi-square.

Chi-square model is specified as:

$X^2 = \sum(O-E)^2/E$ ………………………………………………………………………….. (4)

Where:

$X^2$ = Chi- square;

$\sum$ = Summation of;

O = Observed value of variable; and

E = Expected value of variable.

***Tobit regression***

Tobit regression model assumes that use of adaptation practices is a continuous decision. It expresses farmer's use of adaptation practices as a function of linear combination of observable explanatory variables, some unknown parameters, and an error term (e).

The major strength of Tobit model over other econometric models, such as Ordinary Least Square (OLS) for estimation of adoption, is its inclusion of observations with non-use of adaptation practices. In its simplest form, the Tobit model is presented as:

$Y_i = \beta_{Xi} + e$ ........................................................................................................... (5)

Algebraically expressed for the $i_{th}$ farmer, the Tobit model is explicitly expressed as:

$Y_i = \beta_0 + \beta_1 X_1 +$ .................................................................................................... (6)

$\beta_N X_N \quad i = 1$ ................. $N$

Where: $Y_i$ is the observed dependent variable,that isadaptation to climate change; $\beta_0$is the intercept or the level of use of adaptation practices that will occur regardless of the level of independent variable; $\beta_1$.......................$\beta_N$ are the coefficients of the independent variables; $X_1$......................................... $X_N$ are the independent variables (i.e. age, sex, household size, years of formal education, faming experience, farm size, off-farm employment, rice income, climate change awareness weather information, access to credit, extension contact and years of cooperative membership, affordability, complexity and relative advantage).

Unlike OLS, the Tobit model coefficient does not directly correspond to the expected changes in explanatory variables; rather it estimates a vector of normalized coefficients, which can be transformed into a vector of the first derivative (Tobin, 1958). The Tobit model was also used in several studies of adoption of improved agricultural technologies (Adesina and Zinnah, 1993; Bamire *et al.*, 2002; Ojiako, *et al.*, 2007; Sall *et al.*, 2002).

The empirical model is specified as:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + \beta_{15} X_{15} + \beta_{16} X_{16} + e;$$

Where:

$Y_i$= Use of climate change adaptation practices. These practices are:portfolio diversification (use of improved rice varieties and intercropping), soil conservation (mulching, planting of cover crops, planting of trees, moderate use of fertilizers, moderate use of chemicals and use of organic manure), adjusting the planting calendar (early planting, late planting, late harvesting and early harvesting), use of minimum tillage (zero tillage and making mounds and digging ridges across slopes) and use of irrigation technologies (rainwater harvesting, use of rivers/streams, digging of well and sinking of bore-hole).

e = Error term

$\beta_0$= Constant

$X_1$ = Age of the farmer (In years)

$X_2$ = sex of the farmer (Male = 1or Female = 0)

$X_3$ = Household size (Number of individuals)

$X_4$ = Educational level (Years of acquiring formal education)

$X_5$ = Farming experience (Years)

$X_6$ = Farm size (In hectares)

$X_7$ = Off-farm employment (Yes = 1 or no = 0)

$X_8$ = Income from rice production (₦)

$X_9$ = Climate change awareness (Aware =1, not aware = 0)

$X_{10}$ = Weather information (Number of sources)

$X_{11}$ = Credit access (₦)

$X_{12}$ = Extension contact (Number of contacts in 2015 growing season)

$X_{13}$ = Cooperative membership (In years)

$X_{14}$ = Affordability (Not Affordable = 1, Undecided = 2 and Affordable = 3 )

$X_{15}$ = Complexity (Unusable =1, Undecided = 2and Usable = 3)

$X_{16}$ = Relative advantage (Unfavourable =1,Undecided = 2 and Favourable = 3)

### 4.8.3 Operationalization and measurement of variables

The study considered two sets of variables; dependent and independent variables.

***Dependent variable***

The dependent variable Y is the use of climate change adaptation practices by the farmers.The climate change adaptation practicesfor this study were derived based on observation and relevant literature. They include:

i. **Portfolio diversification**: Specific categories encapsulated in this option are using improved rice varieties and intercropping.Each of the two categories was scored 1, if used by the farmer and 0, otherwise.

ii. **Soil conservation**: Farmers' specific adaptation options listed in this category include mulching, planting of cover crops, planting of trees, moderate use of fertilizer (use of recommended level of fertilizer), moderate use of chemicals (use of recommended level of chemicals) and use of organic manure. Each of the categories was scored 1, if used by the farmer and 0, otherwise.

**iii.** **Adjusting the planting calendar**: This covers early planting and late planting options. Late harvesting and early harvestingare also captured in this option. Each of the two categories was scored 1, if used by the farmer and 0, otherwise.

iv. **Use of minimum/zero tillage:** Zero tillage is a way of growing crops from year to year without disturbing the soil through tillage. Farmers employ it to reduce time, labour and machine operations as well as conserve moisture and reduce erosion. It also involves making mounds and digging ridges across slopes in the farm against erosion and flood. Each of the categories was scored 1, if used by the farmer and 0, otherwise.

v. **Use of irrigation technologies**: This involves supplying water to the farm constantly especially during dry season for crop production throughrainwater harvesting, use of rivers/streams, digging of wells and sinking of bore-holesby the rice farmers. Each of the categories was scored 1, if used by the farmer and 0, otherwise.

Whenever there is a blend of many practices, the measuring of use of these agricultural practices becomes a complex exercise. In this study, use of climate change adaptation practices has been measured by development of a composite index. Composite Index (CI) is an aggregation of use of different dimensions of agricultural practices.

The method used for computing the composite index was based on the traditional method of computing the index for each indicator or dimension. Conventionally, index for any dimension is computed using the formula (1):

$$Dimension\ Index = \frac{Actual\ \ Value - Minimum\ \ Value}{Maximum\ \ Value - Minimum\ \ Value} \text{ .......... (1)}$$

Following this, a composite index was developed by computing the weighted average. It was presumed that $D_{ij}$represented the value of the dimension index for the $j^{th}$ state of the $i^{th}$indicator, then one gets equation (1):

$$I_j = \sum_{i=1}^{n} W_i D_{ij} \text{ .......... (2)}$$

where, $I_j$ is the composite index for the $j^{th}$ state, and $W_i$is the weight assigned to the $i^{th}$indicator (For equal weights, $w_i = 1/n$) and

$$D_{ij} = \frac{X_{ij} - Min\,(X_i)}{Max\,(X_i) - Min\,(X_i)} \text{ .......... (3)}$$

Composite Index for this study was thus obtained for the climate change adaptation practices.

***Independent variables***

The choice of independent variables for this study is influenced by literature reviewed on factors that influence climate change adaptation practices among rice farmers in the study area. Socioeconomic, institutional and technological factors were hypothesized to explain the dependent variable.

***Socioeconomic variables***

The socioeconomic variables for this study are as follows:

i. **Age**: This was the number of years an individual has lived from birth to present. Since variation in climate takes a relatively long period of time, the apriori expectation is that the older farmers will be more aware of climate change than the younger ones.However, young farmers are more likely to be willing to adapt to climate change as older farmers may be less willing to adapt given the heavy labour requirements involved. It is generally believed that as farmers grow older, they are less amenable to change from their old practices. They are also more likely to posses the knowledge and ability to use the indigenous climate change adaptation practices.Age is therefore expected to take either positive or negative sign.It is measured in years.

ii. **Sex**: Sex refers to the sum of the characteristics that distinguish the farmers on the basis of their reproductive function. It is either of the two categories, male or female, into which the farmers are placed on this basis. Sex is therefore measured as 1, if male and 2, iffemale. The apriori expectation was that male farmers are more likely to use the climate change adaptation practices than their female counterparts.

iii. **Household size**:This is the number of peoplewho reside in the same dwelling and also share meals or living accommodation, and may consist of a single family or some other grouping of people.The larger the household size the larger the demand for the basic necessities of life such as food, clothing, shelter and education. Farmers with larger household sizes have more domestic responsibilities. Such responsibility may be a driving force for them to use the climate change adaptation practices to minimize losses in rice production. Larger households in Nigeria, especially in the north, provide more hands for manual labour. Household size wasmeasured by the number of people in a household.The apriori expectation was that the larger the household size the more the use of the climate change adaptation practices among the rice farmers.

iv. **Level of education**:This is the level of formal education acquired by the farmer. It is determined by the number of years spent acquiring education through formal attendance of schools and colleges. The variable is in three categories coded 1 if the farmer attained primary education, 2 if he/she attained secondary education and 3 if the farmer attained tertiary education. Education is expected to positively affect the use of climate change adaptation practices among the farmers.

v. **Farming experience**:This is the number of years spent by the farmer in rice production. Farmers with more experience are more likely to be aware of the need to use the climate change adaptation practices. It is therefore expected to have a positive influence on climate change adaptation practices among the farmers. It was measured in years.

vi. **Farm size**:Farm size refers to the actual land area used by the farmer for rice production. It is expected that the larger the farm size the more the use of the adaptation practices. Farm size is expected to have a positive influence on climate change adaptation practices among the farmers. It was measured in hectares.

vii. **Off-farm employment**:In northern Nigeria, majority of rice farmers depend on rainfall for the growth of rice. Production is therefore largely a seasonal affair since rainfall is experienced in less than half of the 12 calendar months. Consequently, some farmers engage in other business activities for additional income. Many of such business activities will likely continue beyond the dry season. The effect is to boost the farmer’s financial resources and hence his/her ability to use new and better technologies. Off-farm employment is likely to enhance the use of adaptation practices since it provides additional income to the farmers. It is expected to have a positive influence on climate change adaptation practices among the farmers.It was a dummy variable with either yes = 1 or no = 0.

viii. **Income from rice production**:This refers to flow of cash or cash-equivalents received by the farmer from rice production in the last season. It is the monetary payment received from the sales of rice and rice products during the season.Responses to climate change through adaptation require sufficient financial well being.Higher income farmers may be less risk averse and have more access to information and longer planning horizons. Rice income is expected to have a positive influence on climate change adaptation practices among the farmers. Itwas measured in ₦.

ix. **Climate change awareness**:Climate change awareness is the ability to perceive, to feel, or to be conscious of climate change without necessarily implying understanding. It is the state of being aware of climate change.For this study, climate change awareness of the farmers was determined through the farmers' awareness of changes in rainfall and temperature patterns over time. It is expected to have a positive influence on climate change adaptation practices among the farmers. For this study, climate change awareness was measured as not aware = 1 or aware = 2.

x. **Accessibility to Information on weather**: Access to weather information can increase the possibility of using the adaptation practices to climate change mitigation. It is therefore expected to have a positive influence on climate change adaptation practices among the farmers.It was measured by the number of sources or channels through which the information is obtained.

***Institutional variables***

Institutional variables for this study were discussed as follows:

i. **Access to credit**:Credit is a contractual agreement in which a borrower receives something of value now and agrees to repay the lender at some date in the future, generally with interest. Credit allows an individual or group to provide money or resources to a farmer for production purpose with an arrangement to repay or return the resources at a later date. Access to credit is likely to enhance the use of climate change adaptation strategies by the farmer.It is expected to have a positive influence on climate change adaptation practices among the farmers. Access to credit (amount accessed) was measured in ₦.

ii. **Extension contact**:This is the number of times a farmer receives extension agents for extension services in the last production season. The apriori expectation is that the higher thefrequency of extension contacts the more the use of climate change adaptation practices due to enlightenment by the extension agents. Extension contact was measured in the number of contacts per growing season.

iii. **Cooperative membership**: This was determined by the number of years spent by the farmer as a member of anassociation. Older members of an association are more likely to use climate change adaptation practices.Cooperative membership is expected to have a positive influence on climate change adaptation practices among the farmers. It is measured in the number of years in the cooperative society.

***Technological variables***

These variables were earlier described as attributes of climate change adaptation practices. They include:

i. **Affordability**:This reflects the perceived ability of the farmers to meet the financial obligation of climate change adaptation practices. The apriori expectation is that the higher the affordability, the higher the use of the climate change adaptation practices among the farmers. Affordability was measured as: Affordable = 3, undecided = 2 and not affordable = 1.

ii. **Complexity**: This reflects the farmers' perceived difficulty to understand and use the climate change adaptation practices. The apriori expectation is that the higher the complexity, the lower the use of the climate change adaptation practices among the farmers.Complexity was measured as usable = 3, undecided = 2 and not usable = 1.

iii. **Relative advantage:** This reflects how the climate change adaptation practicesare subjectively perceived as superior to the previous idea. The apriori expectation is that the higher the relative advantage, the higher the use of the climate change adaptation practices among the farmers.It was measured as favourable = 3 undecided = 2 and unfavourable = 1).

***Effect variables***

The independent variables are expected to have influence on the dependent variable resulting in expected outcomes called effect variables. The effect variables for this study included:

i. **Change in rice yield:** As an observable outcome, change in rice yield is the increase or decrease inthe quantity of rice produced per unit area. However, with the use of the climate change adaptation practices, rice yield is expected to increase.

ii. **Change in income from rice production:** This refers to the increase or decreasein earnings, returns or proceeds of cash or cash-equivalents received by the farmer from rice production. Rice income can be increased with increase in yield following the use of climate change adaptation strategies by the rice farmers..

iii. **Change in level of living:**Change in level of living of a farmer for this study refers to change in his level of possessions of assets. Use of climate change adaptation practices by the rice farmers is expected to have a significant effect on their acquired assets.

# CHAPTER FIVE

# RESULTS AND DISCUSSION

This chapter contains the presentation and discussion of the study findings. The findings consist of result of the analyses of both the descriptive and inferential statistics.The study results are presented here and the findings, discussed. Some of the findings are on the socioeconomic characteristics of the respondents, climate change awareness, use of climate change adaptation practices, rice production, land use etc.

## 5.1 SocioeconomicCharacteristics of the Respondents

Socioeconomic characteristics discussed include age, sex, marital status, household size, occupation,educational qualification, farming experience and rice income of the respondents.

### 5.8.2 Age of the respondents

Age is an important factor not only for the knowledge of changes in the climate over time by the farmer, but in making decision in the use of climate change adaptation practices. Majorityof the respondents, about 60% in Kebbi and 75% in Sokoto States and fell within the range of 41–60 years while 68% in Zamfara State were found within the range of 21-40 years. Overall, about 62% fell within the 41–60 year range. The mean ages were about 46, 47 and 47 for Kebbi, Sokoto and Zamfara States, respectively with 47 being the overall average (Table 5.1). This result indicates that the respondents were still in their economically active age since the average age is less than 50 years.

**Table 5.1: Distribution of respondents according to their socio-economic characteristics**

| Variable | Kebbi State (n=279) Freq | % | Sokoto State (n=187) Freq | % | Zamfara State (n=56) Freq | % | Pooled Sample (n=522) Freq | % |
|---|---|---|---|---|---|---|---|---|
| **Age (years)** | | | | | | | | |
| 21-40 | 103 | 36.92 | 43 | 23.00 | 38 | 67.86 | 184 | 35.25 |
| 41-60 | 167 | 59.88 | 140 | 74.86 | 14 | 25.00 | 321 | 61.49 |
| Above 60 | 9 | 3.20 | 4 | 2.14 | 4 | 7.14 | 17 | 3.26 |
| **Mean age** | | **45.77** | | **46.48** | | **47.34** | | **46.53** |
| **Sex** | | | | | | | | |
| Male | 260 | 93.19 | 176 | 94.12 | 52 | 92.86 | 488 | 93.49 |
| Female | 19 | 6.81 | 11 | 5.88 | 4 | 7.14 | 34 | 6.51 |
| **Marital status** | | | | | | | | |
| Married | 237 | 84.95 | 173 | 92.51 | 48 | 85.71 | 458 | 87.74 |
| Single | 15 | 5.38 | 3 | 1.60 | 3 | 5.36 | 21 | 4.02 |
| Widow | 18 | 6.45 | 10 | 5.35 | 3 | 3.36 | 31 | 5.94 |
| Widower | 9 | 3.23 | 1 | 0.53 | 2 | 3.52 | 12 | 2.30 |
| **Household size** | | | | | | | | |
| Below 5 | 45 | 16.13 | 23 | 12.30 | 7 | 12.50 | 75 | 14.37 |
| 5-9 | 77 | 27.60 | 68 | 36.36 | 5 | 8.93 | 150 | 28.74 |
| 10-14 | 125 | 44.80 | 85 | 45.46 | 8 | 14.29 | 218 | 41.76 |
| 15-19 | 32 | 11.47 | 7 | 3.74 | 22 | 39.29 | 61 | 11.67 |
| Above 19 | 0 | 0.00 | 4 | 2.14 | 14 | 25.00 | 18 | 3.45 |
| **Mean household size** | | **11.14** | | **14.11** | | **18.86** | | **14.70** |
| **Major occupations** | | | | | | | | |
| Farming | 244 | 87.46 | 174 | 93.05 | 46 | 82.14 | 464 | 88.89 |
| Trading | 24 | 8.60 | 3 | 1.60 | 4 | 7.14 | 31 | 5.94 |
| Fishing | 2 | 0.72 | 4 | 2.14 | 0 | 0.00 | 6 | 1.15 |
| Civil Service | 6 | 2.15 | 5 | 2.67 | 3 | 5.36 | 14 | 2.68 |
| Transporting | 3 | 1.00 | 1 | 0.53 | 3 | 5.36 | 7 | 1.34 |
| **Minor occupations** | | | | | | | | |
| Trading | 162 | 58.06 | 78 | 41.71 | 24 | 42.86 | 264 | 50.58 |
| Farming | 56 | 20.07 | 34 | 18.18 | 26 | 46.43 | 116 | 22.22 |
| Civil Servant | 27 | 9.68 | 13 | 6.95 | 1 | 1.79 | 41 | 7.85 |
| Fishing | 22 | 7.89 | 54 | 28.88 | 4 | 7.14 | 80 | 15.33 |
| Others | 12 | 4.30 | 8 | 4.27 | 1 | 1.79 | 21 | 4.02 |
| **Highest educational qualification** | | | | | | | | |
| Non formal | 109 | 39.01 | 101 | 54.01 | 23 | 41.07 | 233 | 44.64 |
| Primary | 31 | 11.11 | 42 | 22.46 | 13 | 23.21 | 86 | 16.48 |
| Secondary | 93 | 33.33 | 35 | 18.72 | 16 | 28.57 | 144 | 27.59 |
| Tertiary | 46 | 16.49 | 9 | 4.81 | 4 | 7.14 | 59 | 11.30 |
| **Farming experience (years)** | | | | | | | | |
| 5-9 | 15 | 5.38 | 9 | 4.81 | 2 | 3.52 | 26 | 4.98 |
| 10-14 | 26 | 9.32 | 19 | 10.16 | 5 | 8.93 | 50 | 9.58 |
| 15-19 | 17 | 6.09 | 25 | 13.37 | 7 | 12.50 | 49 | 9.39 |
| 20-24 | 90 | 32.26 | 98 | 52.41 | 12 | 21.43 | 200 | 38.31 |
| 25-29 | 83 | 29.75 | 21 | 11.23 | 19 | 33.93 | 123 | 23.56 |
| Above 29 | 48 | 17.20 | 15 | 8.02 | 11 | 19.64 | 74 | 14.18 |
| **Mean farming experience** | | **24.64** | | **24.98** | | **26.86** | | **25.49** |
| **Income from rice production (₦)** | | | | | | | | |
| Below 50000 | 6 | 2.15 | 0 | 0.00 | 1 | 1.79 | 7 | 1.34 |
| 50000-499999 | 225 | 80.65 | 179 | 95.72 | 47 | 83.93 | 451 | 86.40 |
| 500000-949999 | 30 | 10.75 | 8 | 4.28 | 8 | 14.29 | 46 | 8.81 |
| More than 949999 | 18 | 6.45 | 0 | 0.00 | 0 | 0.00 | 18 | 3.45 |
| **Mean rice income** | | **370,933.20** | | **239,516.00** | | **315,776.80** | | **308,742.00** |

This finding agrees with Adebayo *et al.* (2012) who reported, in a study to determine farmers' awareness, vulnerability and adaptation to climate change in Adamawa State, Nigeria, that about 51% of the farmers were between 31-50 years and about 26% of the farmers were up to 30 years of age, while farmers that were over 50 years of age constituted about 23%, which implied that most of the famers were relatively young and physically active. They stressed that the finding had a direct bearing on the availability of able bodied manpower for agricultural production and also on the ease of use of climate change adaptation strategies. Also, age influenced the ability to seek and obtain off-farm jobs and income, which could increase farmers' income and could help cope with adverse change in climate.

However, in a study to determine the effects of climate change adaptation strategies on food crop production efficiency in South western Nigeria, Otitoju, (2013) reported that majority (70%) of food crop farmers in Savanna and the Rainforest agro-ecological zones of Southwestern Nigeria, fell within 20-60 years of age with an average of 53 years. He stressed that the farmers were not within the economically active age range. Therefore food crop production was tending towards the declining productivity class of greater than 50 years. He added that if the occupation did not witness the injection of young able men food crop production might suffer set back.

Chavanapoonphol *et al.* (2005) also found that Thailand rice farmers were quite old with average age of 51 years. Nwaru and Onuoha (2010) discovered that their respondents were a bit old with average age of about 52 and 55 years for smallholder food crop farmers using credit and those not using credit respectively in Imo State, Nigeria.However, Otitoju (2013) found that small and medium-scale soybean farmers in Benue State, Nigeria had average ages of 33 and 39 years respectively.

Deressa *et al.* (2010) argued that age of the household head represents experience in farming. The older the farmer, the more experienced he/she is in farming and the more he or she is exposed to past and present climatic conditions over longer horizons of his/her life spans. Influence of age on the farmer's decision to adapt climate change is mixed (Galvin *et al.,* 2001). Seo *et al.*(2005) found age to negatively influence the probability of a farmer to adapt to climate change while Gbetibouo (2009) found a positive relationship. This variable is therefore expected to take either appositive or negative sign. Hassan and Nhemachena (2008) found age to be insignificant in influencing farmers' adaptation to climate change.However, Adesina and Zinnah (1993) mentioned that it is generally believed that as farmers grow older, they are less amenable to change from their old practices

### 5.8.3 Sex of the respondents

Majority of the respondents,about 93% in Kebbi, 94%in Sokoto and 93% in Zamfara Stateswere males. Overall, about 94% of them were males(Table 5.1). This indicates that rice farming in these three States is dominated by males. It is typical of the male dominance on the issue of gender parity or disparity. It also agrees with Ishaya and Abaje (2008); Abraham *et al.* (2012) that the agricultural sector and the tedious activities related to climate change adaptation strategies are dominated by males.

### 5.8.4 Marital status

Majority of the respondents,about 85% in Kebbi,93% in Sokoto and 86% in ZamfaraStates were married. Overall, 88% of them were married(Table 5.1). Marriage is an important aspect of the life of the farmers. Every individual who attained the right age is expected to marry, hence, only about 5%, 2% and 5% of the respondents were found single in Kebbi, Sokoto and Zamfara States, respectively. It indicates that majority of the respondents were saddled with the responsibility of catering for their family.This can create the need for portfolio diversification as a climate change adaptation strategies, in order to meet the various needs of the family members.

### 5.8.5 Household size

Table 5.1 shows that about 45% and 46% of the respondents in Kebbi and Sokoto States, respectively, had a family size of 10-14 individuals. A larger proportion of the farmers in Zamfara State (39%) had 15-19 members in their households. Overall, about 42% of the respondents had a family size of 10-14 individuals. The mean household sizes were about 11, 14 and 19 for Kebbi, Sokoto and Zamfara States, respectivelywith an overall mean of about 15(Table 5.1).This indicates that majority of the respondents had at least 10 individual members in their households. This is on the high side due to the polygamous lifestyle of the farmers and for the fact that unmarried sons often remain in the family.

Household size is the function of spouses, children and dependants staying and eating under the same household head (Fatuase *et al.*, 2015). Ordinarily, this will make the farming households to accomplish various agricultural tasks as a result of higher labour endowments as reported by Deressa *et al*. (2011). Abaje *et al.* (2014) observed that large household size is believed to provide cheap labour that will assist in practices that will mitigate the impacts of climate variability and change by the respondents. This is because some of the resources and items that could be used in combating the impacts of climate variability and change cannot be afforded as the average annual income of the farmers is too meagre.

Household size is assumed to represents the labour input to the farm (Mudzonga, 2012). While Mano and Nhemachena (2006) argued that large household size is mostly inclined to divert part of its labour force into non farming activities, Hassan and Nhemachena (2008) argued that the opportunity cost might be too low in most small holder farming systems as off farm opportunities are difficult to find in most cases. Hassan and Nhamachena (2008) revealed that household size showed mixed impacts in many studies. Gbetibouo (2009) found household size to enhance the farmer's adaptive capacity to respond to climate change contrary to findings by Deressa *et al.* (2009) and Apata *et al.*(2009).

### 5.8.6 Major occupations

Major occupations for this study refer to the occupations that the farmer considers more important for his livelihood. Most of the respondents in Kebbi (88%), Sokoto (93%) and Zamfara States (82%) took farming as their major occupation, hence, majority (89%) of the respondents were primarily farmers. Few of the farmers considered other occupations such as trading (6% overall, 9%, 2% and 7% in Kebbi, Sokoto and Zamfara States, respectively) fishing (1% overall, 1%, and 2% in Kebbi and Sokoto States, respectively), civil service (3% overall, 2%, 3% and 5% in Kebbi, Sokoto and Zamfara States, respectively) and transporting (1% overall, 1%, each for Kebbi and SokotoStates and5% in Zamfara State) as their major occupations (Table 5.1).This implies that the farmers considered farming as more important than any other occupation they may have. Farming to them is the major source of livelihood.

### 5.8.7 Minor occupations

These are occupations available to the farmers that are considered less important than the major occupations. Findings shows that larger proportions of the respondents,about 58% in Kebbi State and 93% in Sokoto State considered trading as their minor occupation while 46%

of the respondents in Zamfara State took farming as a minor or secondary occupation. Overall, about 51% of themconsidered trading as their minor occupation (Table 5.1). From all indications, some of the famers from the three states considered faming (22% overall, 20%, 18% and 46% in Kebbi, Sokoto and Zamfara States, respectively) as both major and minor occupations. They most likely, farm throughout the year.

### 5.8.8 Highest educational qualification

Results of the study reveal that over 55% of the total respondents, 60% in Kebbi State hadprimary, secondary or tertiary education. Similarly, about 59% of the respondents in Zamfara State had primary, secondary or tertiary education. However, a larger segment (54%) of the respondents in Sokoto States had no formal education (Table 5.1). This implies that majority of the respondents in Kebbi and Zamfara States had one form of formal education or another, while their counterparts in Sokoto State had mainly Qur'anic education which is a non-formal education.

Formal education among farmers can favour their use of climate change adaptation practices through their literacy level.This agrees with Adebayo *et al.* (2012) who reported that, about 70% of the farmers in Adamawa State, Nigeria had some form of formal education and concluded that the literacy level among the farmers was high and which could have implication for agricultural production and also for adaptation to changes in the climate. They observed that adoption of measures that could result in climate change adaptation is also easier and faster among the educated farmers than the uneducated farmers.

Maddison (2006) argues that education diminishes the probability that no adaptation is taken. In other words, it has a positive impact on adoption of climate change adaptation practices.

### 5.8.9 Farming experience

About 32% and 52% of the respondents in Kebbi and Sokoto States, respectively, had a farming experience of 20-24 years, while 33.93% of the respondents in Zamfara State had an experience of 25-29 years. Overall, 38.31% of the respondents had 20-24 years of farming experience (Table 5.1). The fact that none of the respondents had an experience of less than 5 years indicates that they were not new into farming. The mean farming experience was25.49, specifically, 24.64, 24.98 and 26.86 years for Kebbi, Sokoto and Zamfara State farmers, respectively.

The more experienced the farmer is, the more he/she is better informed about the changes in climate and the more he/she is likely to employ adaptation measures that reduce the impact of climate change on his/her agricultural activities (Mudzonga, 2012). It is farming experience that matters more than merely the age of the farmer when it comes to adaptation to climate change (Hassan and Nhemachena, 2008). Studies by Maddison (2006) and Hassan and Nhemachena (2007) indicated that more farming experience increases the probability of a farmer adapting to climate change.

### 5.8.10 Income from rice production

Rice income refers to the earnings, returns or proceeds of cash or cash-equivalents received by the farmers from rice production. Results of the study show that majority of the respondents,about 81% in Kebbi, 96% in Sokoto and 84% in Zamfara States had an income from rice production, within the range of ₦50,000.00 to ₦499,999.00.Overall, about 86% of them had their income from rice production, within the ₦50,000.00 to ₦499,999.00 range. The mean rice income was₦308,742.00, specifically, ₦370,933.00, ₦239,516.00 and ₦315,776.80 for Kebbi, Sokoto and Zamfara State farmers, respectively (Table 5.1).

### 5.8.11 Land used by the farmers

This section provides information on land used by the rice farmers. The information is basically on the ownership system and size of the land.

***Land ownership***

Results of this study indicate that majority of the respondents, with about 95% in Kebbi State, 96% in Sokoto State and 89% in Zamfara State owned their land through inheritance. Overall, about 93% of the farmers owned their land through inheritance. About 22% of the farmers in Kebbi State, 28% in Sokoto State and 16% in Zamfara State acquired their land through purchase. Therefore 23% of the respondents acquired their land through purchase. Moreover, very few of the respondents acquired land through lease/rent (Table 5.2). This indicates that land ownership system in the study area is largely by inheritance.

***Land size***

Land size refers to the total land area belonging to a farmer. This study reveals that majority of the respondents, about 79%, in Kebbi State, 98% in Sokoto State and 93% in Zamfara State owned lands within the range of 1-4 hectares. In all, about 86% of the respondents owned lands within the range of 1-4 hectares. Only about 8% of the respondents owned lands within the range of 5-8 hectares, with 12% of them in Kebbi State, 2% in Sokoto State and 5% in Zamfara State. Very few of the respondents (about 4%) owned more than 8 hectares of land. The mean land sizes are 3.38, 2.55 and 2.80 hectares for Kebbi, Sokoto and Zamfara States, respectively, with an overall mean of 2.91 hectares (Table 5.2).

**Table 5.2: Distribution ofrespondents according to land used**

| Variable | Kebbi State (n=279) | | Sokoto State (n=187) | | Zamfara State (n=56) | | Pooled Sample (n=522) | |
|---|---|---|---|---|---|---|---|---|
| | Freq | % | Freq | % | Freq | % | Freq | % |
| **Land ownership** | | | | | | | | |
| Inheritance | 265* | 94.98 | 172* | 96.09 | 50* | 89.29 | 487 | 93.30 |
| Purchase | 60* | 21.51 | 50* | 27.93 | 9* | 16.07 | 119 | 22.80 |
| Rent/lease | 16* | 5.74 | 15* | 8.38 | 3* | 5.36 | 34 | 6.51 |
| **Land size (ha)** | | | | | | | | |
| 1 – 4 | 221 | 79.21 | 176 | 98.32 | 52 | 92.86 | 449 | 86.02 |
| 5 – 8 | 34 | 12.19 | 3 | 1.68 | 3 | 5.36 | 40 | 7.66 |
| More than 8 | 24 | 8.60 | 0 | 0.00 | 1 | 1.79 | 25 | 4.79 |
| **Mean land size** | | **3.38** | | **2.55** | | **2.80** | | **2.91** |
| **Land area for rice production (ha)** | | | | | | | | |
| Less than 1 | 164 | 58.78 | 125 | 69.83 | 33 | 58.93 | 322 | 61.69 |
| 1 – 4 | 101 | 36.20 | 54 | 30.17 | 21 | 37.50 | 176 | 33.72 |
| 5 – 8 | 14 | 5.02 | 0 | 0.00 | 2 | 3.57 | 16 | 3.07 |
| **Mean land area for rice production** | | **0.70** | | **0.68** | | **0.91** | | **0.83** |

*Multiple responses

This indicates that a rice farmer in the North-West, Nigeria has at least one hectare of land. Farm size determines the land allocation of the modern crop varieties. The bigger the farm size, the more likely the farmer is to adopt suitable strategies (Mudzonga, 2012).

***Land area for rice production***

A section of the land area belonging to the farmer is devoted for rice production. Results of this study show that about 59% of the respondents in Kebbi State, 71% in Sokoto State and 70% in Zamfara State devoted less than 1 hectare for rice production. Overall, about 63% of them devoted less than 1 hectare for rice production. Only about 36% of the respondents in Kebbi State, 30% in Sokoto State and 38% in Zamfara State devoted 1-4 hectares of their land to rice production. Overall, about 34% of the farmers devoted 1-4 hectares of their land to rice production. The mean land sizes devoted to rice were 0.70, 0.68 and 0.91 hectares for Kebbi, Sokoto and Zamfara States, respectively, with an overall mean of 0.83 hectares (Table 5.2).

### 5.8.12 Membership of cooperative societies

Membership of cooperative societies is a form of social participation considered relevant for this study due to its potential in increasing the farmers' resources (both financial and otherwise). It can therefore increase the farmers' awareness level of climate change adaptation practices, hence, the chances of using them. Majority of the respondents, 94% in Kebbi, about 83% in Sokoto and 88% in Zamfara States had cooperatives membership. Overall, (about 89%) of them had cooperatives membership (Table 5.3). This implies that majority of the farmers belonged to cooperative societies.

**Table 5.3: Distribution of respondents according to membership of cooperative societies**

| Variable | Kebbi State (n=279) | | Sokoto State (n=187) | | Zamfara State (n=56) | | Pooled Sample (n=522) | |
|---|---|---|---|---|---|---|---|---|
| | Freq | % | Freq | % | Freq | % | Freq | % |
| **Membership of cooperative societies** | | | | | | | | |
| Had membership | 261 | 93.55 | 156 | 83.42 | 49 | 87.50 | 466 | 89.27 |
| Had no membership | 18 | 6.45 | 31 | 16.58 | 7 | 12.50 | 56 | 10.73 |
| **Years of cooperative membership** | | | | | | | | |
| 1-4 | 95 | 36.40 | 89 | 55.63 | 8 | 16.33 | 192 | 36.78 |
| 5-9 | 73 | 27.97 | 46 | 28.75 | 36 | 73.47 | 155 | 29.69 |
| 10-14 | 56 | 21.46 | 3 | 1.88 | 4 | 8.16 | 63 | 12.07 |
| More than 14 | 37 | 14.18 | 22 | 13.75 | 1 | 2.04 | 60 | 11.49 |
| **Mean years of membership** | | **7.18** | | **6.99** | | **5.16** | | **6.44** |

### 5.8.13 Years of cooperative membership

The results further reveal that majority of the respondents in Zamfara State had been members of cooperative societies for 5-9 years, while 56% and 36.40% in Sokoto and Kebbi States respectively, had their membership within the range of 1-4 years. About 36.78% of the entire respondents also had been members of cooperative for 1 to 4 years. The mean farming experience was 6.44 years for the entire respondents,7.18, 6.99 and 5.16 years for Kebbi, Sokoto and Zamfara State farmers, respectively (Table 5.3).

**Table 5.4: Distribution of respondents according to access to credit**

| Variable | Kebbi State (n=279) | | Sokoto State (n=187) | | Zamfara State (n=56) | | Pooled Sample (n=522) | |
|---|---|---|---|---|---|---|---|---|
| | Freq | % | Freq | % | | Freq | % | Freq |
| **Access to credit** | | | | | | | | |
| Had access | 217 | 77.78 | 164 | 87.70 | 38 | 67.86 | 419 | 80.27 |
| Had no access | 62 | 22.22 | 23 | 12.30 | 18 | 32.14 | 103 | 19.73 |
| **Sources of credit** | | | | | | | | |
| Informal sources | 179* | 64.16 | 142* | 86.59 | 35* | 93.11 | 356 | 68.20 |
| Private Commercial Banks | 54* | 19.36 | 27* | 16.46 | 7* | 18.42 | 88 | 16.86 |
| Government Loan Scheme | 162* | 58.70 | 117* | 71.34 | 11* | 28.95 | 290 | 55.56 |
| **Value of credit accessed (₦)** | | | | | | | | |
| Less than 15000 | 0 | 0.00 | 0 | 0.00 | 1 | 2.78 | 1 | 0.19 |
| 15000-104999 | 154 | 70.97 | 158 | 96.34 | 30 | 83.33 | 342 | 65.52 |
| 105000-194999 | 37 | 17.05 | 6 | 3.66 | 3 | 8.34 | 46 | 8.81 |
| More than 194999 | 26 | 11.98 | 0 | 0.00 | 2 | 5.56 | 28 | 5.36 |
| **Mean value of credit accessed (₦)** | **72731.18** | | **51213.92** | | **35178.57** | | **53041.22** | |

*Multiple responses

### 5.8.14 Access to credit

Table 5.4 shows that majority of the respondents, about 78% in Kebbi, 88% in Sokoto and 68% in Zamfara States had access to credit.Overall, over 80% of them had access to credit. This indicates that loans could be accessed by rice farmers in the three States. Access to credit ease-off the financial constraints of the farmer. Credit availability enhances the probability of a farmer to adapt strategies that reduce the negative impact of climate change to his/her household (Mudzonga, 2012). The farmer will be in a position to finance adoption of new technologies such as oxen, improved crop variety seed and fertilizer. Findings by Gbetibouo (2009), Deressa *et al.* (2009) and Fosu- Mensah *et al.* (2010) indicated that access to credit significantly influences the farmer to adapt to climate change.

### 5.8.15 Sources of credit

Study findings reveals that majorityof the respondents, about64%, 87% and 93%in Kebbi, Sokoto and Zamfara States, respectively, obtained credits from informal sources. Overall, 80% of themobtained credits from informal sources. About59% of the respondents in Kebbi, 71% in Sokoto, and 29%in Zamfara State obtained credits from Government Loan Schemes.

Overall, 56% of themobtained credits from Government Loan Schemes (Table 5.4).This implies that most of the farmers obtainedcredits from informal sources and Government Loan Schemes to finance their farming activities.

### 5.8.16 Amount accessed

Majority of the respondents,about71% in Kebbi, 96% in Sokoto and 83% in Zamfara States obtained credits within the range of₦15,000 -₦104,999 in value. Overall, 66% of them obtained credits within the ₦15,000 - ₦104,999 range . Only about 12% and 6% of the farmers in Kebbi and Zamfara States respectively, obtained more than ₦194,999 worth ofcredit (Table 5.4).

### 5.8.17 Off- farm employment

It is common for some farmers to engage in other business activities for additional income. Many of such business activities will likely continue beyond the dry or off-farming season, such that they move hand in hand with farming activities. This study reveals that onlyabout11% of the respondents in Kebbi, 12% in Sokoto and 32% in Zamfara States had no off-farm employment.Overall, about14% of the total respondents had no off-farm employment. They depended solely on farming year in, year out for their livelihoods (Table 5.5).

However, 54% of the farmers, 64%, in Kebbi, 41% in Sokoto and 48%, in Zamfara States were engaged in trading. Similarly, 16% of the respondents, 9% in Kebbi and 31% in Sokoto States were engaged in fishing.Only about10% of them, 11% in Kebbi, 7% in Sokoto and 11% in Zamfara States were civil servants (Table 5.5). This indicates that majority of the respondents had off-farm employments. They do not depend entirely on farming as a source of livelihoods. This, in addition to diversification of crop enterprise, can be an additional source of income and therefore safeguard the farmers against the adverse effects of total production loses.It also increases their financial status in financing the use of climate change adaptation practices.

However, it is evident that rural households in Nigeria engage in multiple livelihood activities such as trading, small scale business enterprises and processing of agricultural goods and arts and craft in order to supplement earnings from agriculture (Matthews-Njoku *et al.*, 2007; Ekong, 2010; Adepoju and Obayelu, 2013).

### 5.8.18 Off-farm annual income

Having off-farm employment ensures an additional source of income to the farmers. Result of this study reveals that majority of the respondents,about80% of them in Kebbi, 84% in Sokoto and 87% in Zamfara States had an off-farm annual income within the range of ₦15,000-₦499,999.Overall, about71% of them had an off-farm annual income within the ₦15,000-₦499,999 range. Only about12% of the respondents, 20% of them in Kebbi, 5% in Sokoto and 13% in Zamfara States, had more than ₦499,999 as their off-farm annual income. The mean off-farm annual income was ₦252,741.90, with ₦322,724.00 in Kebbi, ₦199,010.70 in Sokoto and ₦236,491.10 in Zamfara States (Table 5.5).

Off-farm income is income derived from activities that are not associated with farming (Mudzonga, 2012). Responses to climate change through adaptation require sufficient financial well being (Deressa *et al.*, 2009). In support to this argument, CIMMYT (1993) notes that higher income farmers may be less risk averse and have more access to information and longer planning horizons. The effect is to boost the farmer's financial resources and hence his/her ability to use new and better technologies.

**Table 5.5: Distribution of respondents according to off-farm employment and income**

| Variable | Kebbi State (n=279) | | Sokoto State (n=187) | | Zamfara State (n=56) | | Pooled Sample (n=522) | |
|---|---|---|---|---|---|---|---|---|
| | Freq | % | Freq | % | Freq | % | Freq | % |
| **Off- farm employment** | | | | | | | | |
| None | 31 | 11.11 | 23 | 12.30 | 18 | 32.14 | 72 | 13.79 |
| Trading | 178 | 63.80 | 77 | 41.18 | 27 | 48.21 | 282 | 54.02 |
| Fishing | 24 | 8.60 | 58 | 31.02 | 0 | 0.00 | 82 | 15.71 |
| Civil service | 31 | 11.11 | 13 | 6.95 | 6 | 10.71 | 50 | 9.58 |
| Others | 14 | 5.02 | 9 | 4.80 | 4 | 7.15 | 27 | 5.17 |
| **Off-farm annual income (₦)** | | | | | | | | |
| Less than 150000 | 0 | 0.00 | 18 | 10.98 | 0 | 0.00 | 18 | 3.45 |
| 15000-499999 | 198 | 79.84 | 138 | 84.14 | 33 | 86.85 | 369 | 70.69 |
| More than 499999 | 50 | 20.06 | 8 | 4.88 | 5 | 13.16 | 63 | 12.07 |
| **Mean off-farm annual income (₦)** | **322724** | | **199010.70** | | **236491.10** | | **252741.90** | |

### 5.8.19 Extension contact

Analysis of the data for this study provides information on the number of times extension agents were received by the farmers as well as the number of times they were visited by the farmers. It also provides information on the frequent mode of communication between the famers and the extension agents.

***Number of times extension agentsvisited the farmers***

Table 5.6 shows that about56% of the respondents were visited once by extension agents during the year under review (2015). Specifically, about69% of them were visited in Kebbi State, 46% in Sokoto State and 25% in Zamfara State. However, 25% of the respondents in Kebbi State, 52% in Sokoto State and 48% in Zamfara State had no extension contact. Overall, 37% of the respondents had no extension contact. The mean extension agent to farmer visits was 0.72 for the entire respondents, 0.82, 0.51 and 0.82 years for Kebbi, Sokoto and Zamfara State farmers, respectively (Table 5.5). This indicates that majority of the farmers received extension agents during the production season. Farmers need extension visits either for new production packages or for solution to the problems encountered on the existing ones.

Rice farmers in the North-West Nigeria need extension visits mostly on the problems associated with the use of farm inputs such as seeds, fertilizers, chemicals, farm machines, etc. This finding is contrary to Adebayo *et al.* (2012) who reported that majority of farmers in Adamawa State had no contact with extension agents, which could affect climate change adaptation among them, since their understanding of climatic change depends only on their previous experience.

***Number of times farmers visited the extension agents***

There are times when a farmer needs to visit the extension agent especially when the agent cannot be received by the farmer when needed. Findings of this study reveal thatabout66% of the respondents in Kebbi State, 48% in Sokoto State and 45% in Zamfara State visited an extension agent at least once during the production season.Overall, over 57% of them visited an extension agent at least once during the production season. The mean farmer to extension agent visits was 0.91 for the entire respondents,1.51, 0.70 and 0.88 years for Kebbi, Sokoto and Zamfara State farmers, respectively (Table 5.5). This implies that a larger proportion of the farmers visited the extension agents for solution to their production problems.

***Most frequent mode of communication with the extension agents***

Communication channel is essential in conveying the messages across to the farmers from the extension agencies. In this regard, findings of this study reveal that majority of the respondents, about75% in Kebbi State, 48% in Sokoto State and 52% in Zamfara State had a face-to-face communication with the extension agents. Overall, about63% of them had a face-to-face communication with the extension agents. Only about26% and 4% of the respondents communicated with extension agents through electronic and printed media, respectively (Table 5.5). This implies that communication between farmers and extension agents in the study area was mainly through face-to-face.

**Table 5.6: Distribution of respondents according to extension contact**

| Variable | Kebbi State (n=279) | | Sokoto State (n=187) | | Zamfara State (n=56) | | Pooled Sample (n=522) | |
|---|---|---|---|---|---|---|---|---|
| | Freq | % | Freq | % | Freq | % | Freq | % |
| **Number of times extension agents visited the farmers** | | | | | | | | |
| None | 69 | 24.73 | 97 | 51.87 | 27 | 48.21 | 193 | 36.97 |
| Once | 192 | 68.82 | 85 | 45.46 | 14 | 25.00 | 291 | 55.75 |
| Twice | 18 | 6.45 | 5 | 2.67 | 14 | 25.00 | 37 | 7.09 |
| More than twice | 69 | 24.73 | 0 | 0.00 | 1 | 1.79 | 70 | 13.41 |
| **Mean number of times extension agents visited the farmers** | | **0.82** | | **0.51** | | **0.82** | | **0.72** |
| **Number of times farmers visited extension agents** | | | | | | | | |
| None | 95 | 34.05 | 98 | 52.41 | 28 | 50.00 | 221 | 42.34 |
| Once | 57 | 20.43 | 51 | 27.27 | 14 | 25.00 | 122 | 23.37 |
| Twice | 118 | 42.29 | 35 | 18.72 | 9 | 16.07 | 162 | 31.03 |
| More than twice | 9 | 3.23 | 3 | 1.60 | 2 | 3.57 | 14 | 2.68 |
| **Mean number of times farmers visited extension agents** | | **1.15** | | **0.70** | | **0.88** | | **0.91** |
| **Most frequent mode of communication with the extension agents/agency** | | | | | | | | |
| None | 74* | 26.52 | 97* | 51.87 | 27* | 48.21 | 198 | 37.93 |
| Face-to-face | 208* | 74.55 | 90* | 48.13 | 29* | 51.78 | 327 | 62.64 |
| Electronic media | 100* | 35.84 | 26* | 13.98 | 10* | 17.86 | 136 | 26.05 |
| Printed media | 20* | 7.17 | 0* | 0.00 | 0* | 0.00 | 20 | 3.83 |

*Multiple responses

## 5.9 Climate Change Awareness

Climate change awareness level of the farmers and awareness period are discussed. Presented, are also climate change sensitization, sources of climate change awareness and relevance of the information obtained.

### 5.9.1 Climate change awarenesslevel of the farmers

Climate change awareness was determined through the farmers' awareness of changes in rainfall and temperature patterns over time. Result of this study shows that about51% of the respondents in Kebbi State, 26% in Sokoto State and 36% in Zamfara State were fully aware of climate change. Overall, about40% of the respondents were fully aware of climate change. Only 25% of the respondents, 18% in Kebbi State, 33% in Sokoto State and 34% in Zamfara State were not aware of climate change (Table 5.7). This implies that majority of the respondents were aware (either fully or partially) of climate change. Climate changeawareness is the first step in learning and using climate change adaptation practices.Awareness of climate change helps farmers plan their production activities and reduces risks and uncertainties associated with farming (Adebayo *et al*., 2012).

Farauta *et al.* (2011) found that farmers in Northern Nigeria were aware and knowledgeable on the issues of climate change. They added that awareness is a necessary step in adapting to the changing climate. Gworgwor (2008) stated that the uncertainty on the magnitude of change make awareness imminent at all levels. Gworgwor (2008) also suggested that the present solution to man's survival on the earth's environment sustainably hinges on the option of knowledge of climate variability and adopting mitigation and adaptation measures as widely recognized as vital components or approaches to reducing climate variability. Awareness of climate change helps farmers plan their production activities and reduces risks and uncertainties associated with farming (Adebayo *et al.*, 2012).

Access to information on climate change influences the farmers' awareness to changes in climate and creates opportunities for the farmer to adopt suitable strategies that best suit the changed climatic conditions (Mudzonga, 2012). Extension services are made available to the farmer by the government. They serve as technical information source to farmers. Such services provide the farmer with information about the agricultural adaptation practices that are most suitable to their farms. Extension services also inform the farmers about the changing climatic conditions (Mudzonga, 2012). Provision of such services enhances the chances of the farmers to adapt to climate change. Thus exposure to such information increases the farmer's awareness. Hassan and Nhemachena (2007) found that access to information about climate change forecasting, adaptation options and other agriculture activities remain important factors determining the use of various adaptation strategies.

### 5.9.2 Climate change awareness period

Change in climate occurs gradually over a long period of time. Awareness of climate change among farmers does not start at the same period. This study, therefore, reveals that majority of the respondents,about51% in Kebbi, 59% in Sokoto and 78% in Zamfara States were aware of climate change for 2-6 years. Overall, about 60% of them were aware of climate change for 2-6 years. Few of the farmers (4%) were aware of climate change in over 16 year period. The mean awareness period was 5 for the entire respondents, 7, 4 and 4 years for Kebbi, Sokoto and Zamfara State farmers, respectively (Table 5.7). This indicates that the respondents were aware of climate change at different periods within a range of 2-21 years.

### 5.9.3 Climate change sensitization

Sensitization on climate change can enhance its understanding by farmers and increase the chances of using climate change adaptation strategies. Only about13% of the respondents who were found mainly in Kebbi State attended seminars/workshops or meetings on climate change (Table 5.7). This implies that climate changesensitization was too low in the study area.

### 5.9.4 Information obtained at the sensitization

The entire respondents (100%) found in Kebbi State, who attended seminars/workshops or meetings onclimate change, revealed that they obtained information on causes of climate change and its effects on agriculture (Table 5.7). This indicates that the information obtained by the farmers was relevant to their agricultural production activities.

### 5.9.5 Sources of climate change awareness

Sources of climate change awareness refer to the channels through which information on climate change gets to the farmers. This study shows that majority of the respondents, about96% in Kebbi, 99% in Sokoto and 97% in Zamfara States had radio as their source of climate change awareness. Overall, 97% of the farmers had radio as their source of climate change awareness. Similarly, majority of them, 93% in Kebbi, 89% in Sokoto and 97% in Zamfara States relied on fellow farmers as their source of climate change awareness. Overall, 92% of the respondentsrelied on fellow farmers as their source of climate change awareness (Table 5.7).

This implies that radio and fellow farmers were the most important sources of climate change awareness among the farmers.This finding concur with Farauta *et al.* (2011) who revealed that the mass media especially radio and televisions were the major avenues through which farmers sourced information on climate change. Isife and Ofuoku (2008) documented that radio has the highest audience and had the strength of reaching a large population of farmers and other rural dwellers faster than other means of communication. The implication of this finding is that there is need for extension services to rise up to the challenge of dissemination information on climate change issues using the radio and television(mass media).

**Table 5.7: Distribution of respondents according to climate change awareness**

| Variable | Kebbi State (n=279) | | Sokoto State (n=187) | | Zamfara State (n=56) | | Pooled Sample (n=522) | |
|---|---|---|---|---|---|---|---|---|
| | Freq | % | Freq | % | Freq | % | Freq | % |
| **Climatechange awareness level** | | | | | | | | |
| Not aware | 50 | 17.93 | 62 | 33.16 | 19 | 33.93 | 131 | 25.10 |
| Partially aware | 87 | 31.18 | 76 | 40.64 | 17 | 30.36 | 180 | 34.48 |
| Fully aware | 142 | 50.90 | 49 | 26.20 | 20 | 35.71 | 211 | 40.42 |
| **Perceived causes of climate change** | | | | | | | | |
| Destruction of vegetation | 209* | 87.81 | 123* | 65.78 | 35* | 79.55 | 367 | 70.31 |
| Super natural forces/God | 176* | 79.95 | 99* | 52.94 | 33* | 58.93 | 308 | 59.00 |
| Do not know | 6* | 2.52 | 6* | 3.21 | 1* | 2.27 | 13 | 2.49 |
| Poor farming practices | 137* | 49.10 | 81* | 43.32 | 27* | 48.21 | 245 | 46.94 |
| **Climate change awareness period** | | | | | | | | |
| 2-6 | 116 | 50.66 | 86 | 68.80 | 29 | 78.38 | 231 | 59.08 |
| 7-11 | 85 | 37.12 | 45 | 36.00 | 10 | 27.03 | 140 | 35.81 |
| 12-16 | 23 | 10.04 | 0 | 0.00 | 2 | 5.41 | 25 | 6.39 |
| 17-21 | 14 | 6.11 | 2 | 1.60 | 1 | 2.70 | 17 | 4.35 |
| **Mean climate change awareness period** | | **6.95** | | **4.40** | | **4.45** | | **5.27** |
| **Climate change sensitization** | | | | | | | | |
| Attended seminar/workshop or meeting on climate change | 37 | 13.26 | 0 | 0.00 | 0 | 0.00 | 37 | 7.09 |
| Attended no seminar/workshop or meeting on climate change | 242 | 86.74 | 187 | 100.00 | 56 | 100.00 | 485 | 92.91 |
| **Information obtained at the sensitization** | | | | | | | | |
| Causes of climate change | 37 | 100.00 | 0 | 0.00 | 0 | 0.00 | 37 | 7.09 |
| Effects of climate change on agriculture | 37 | 100.00 | 0 | 0.00 | 0 | 0.00 | 37 | 7.09 |
| Climate change adaptation practices | 37 | 100.00 | 0 | 0.00 | 0 | 0.00 | 37 | 7.09 |
| **Sources of climate change awareness** | | | | | | | | |
| Radio | 220* | 96.07 | 124* | 99.20 | 36* | 97.30 | 380 | 97.19 |
| Television | 137* | 59.83 | 39* | 31.20 | 14* | 37.84 | 190 | 48.59 |
| Newspapers | 54* | 23.58 | 9* | 7.20 | 5* | 13.51 | 68 | 17.31 |
| Extension agent | 7* | 3.06 | 0* | 0.00 | 6* | 16.22 | 13 | 3.32 |
| Internet | 6* | 2.62 | 0* | 0.00 | 0* | 0.00 | 6 | 1.54 |
| Fellow farmers | 213* | 93.01 | 111* | 88.80 | 36* | 97.30 | 361 | 92.33 |
| Research institutes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cooperative societies | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Relevance of the information obtained** | | | | | | | | |
| Relevant | 196 | 85.59 | 106 | 84.80 | 29 | 78.38 | 331 | 84.66 |
| Very relevant | 42 | 16.34 | 26 | 20.80 | 12 | 32.43 | 80 | 20.46 |

*Multiple responses

## 5.9.6 Relevance of the information obtained

Majority of the respondents, about86% in Kebbi, 85% in Sokoto and 78% in Zamfara States reported that the source of climate change awareness were relevant. Overall, 85% reported that the source of climate change awareness were relevant (Table 5.7). This implies that the farmers were satisfied with the sources of climate change awareness available to them. This is in spite of the fact that they were not taking much advantage of other channels such as the television, newspapers, extension agents and the internet.

### 5.10 Use of Climate Change Adaptation Practices

This section presents the study findings on use of climate change adaptation practices. The practices include portfolio diversification,which involves the use of improved rice varieties and intercropping; soil conservation, involvingmulching, planting of cover crops, planting of trees, moderate use of fertilizers, moderate use of chemicals and use of organic manure. Otherpractices are adjusting the planting calendar, involving early planting, late planting, early harvesting and late harvesting; use of minimum tillage involvingzero tillage and making mounds and ridges across slopes and use of irrigation technology,involvingrainwater harvesting, use of rivers/streams, digging of well and sinking of bore-hole.

#### 5.10.1 Portfolio diversification

There are two sub-practices under this: the use of improved rice varieties and intercropping. Result of this study shows that majority of the respondents, about89% in Kebbi State, 75% in Sokoto State and 95% in Zamfara State used improved rice varieties. Overall, 84% of them used of improved rice varieties. Similarly, majority (about77%) of the respondents, with 78% in Kebbi State, 71% in Sokoto State and 98% in Zamfara State used intercropping (Table 5.8).

**Table 5.8: Distribution of respondents according to use of CCAP**

| Variable | Kebbi State (n=279) | | Sokoto State (n=187) | | Zamfara State (n=56) | | Pooled Sample (n=522) | |
|---|---|---|---|---|---|---|---|---|
| | Freq | % | Freq | % | Freq | % | Freq | % |
| **Portfolio diversification:** | | | | | | | | |
| Use of improved rice varieties | 247 | 88.53 | 141 | 75.40 | 53 | 94.64 | 441 | 84.48 |
| Intercropping | 217 | 77.78 | 132 | 70.59 | 55 | 98.21 | 404 | 77.40 |
| **Soil conservation:** | | | | | | | | |
| Mulching | 125 | 44.80 | 32 | 17.20 | 20 | 35.71 | 177 | 33.91 |
| Planting of cover crops | 91 | 32.62 | 37 | 19.79 | 21 | 37.50 | 149 | 28.54 |
| Planting of trees | 138 | 49.46 | 63 | 33.69 | 11 | 19.64 | 212 | 40.61 |
| Moderate use of fertilizers | 256 | 91.76 | 180 | 96.26 | 50 | 89.29 | 486 | 93.10 |
| Moderate use of chemicals | 250 | 89.61 | 170 | 90.91 | 49 | 87.50 | 469 | 89.85 |
| Use of organic manure | 279 | 100.00 | 185 | 98.93 | 55 | 98.21 | 519 | 99.43 |
| **Adjusting the planting calendar:** | | | | | | | | |
| Early planting | 270 | 96.77 | 160 | 85.56 | 52 | 92.86 | 482 | 92.34 |
| Late planting | 10 | 3.58 | 27 | 14.44 | 1 | 1.79 | 38 | 7.28 |
| Early harvesting | 265 | 94.98 | 167 | 89.30 | 54 | 96.43 | 486 | 93.10 |
| Late harvesting | 15 | 5.38 | 20 | 10.70 | 2 | 3.57 | 37 | 7.09 |
| **Use of minimum tillage:** | | | | | | | | |
| Zero tillage | 12 | 4.30 | 11 | 5.88 | 0 | 0.00 | 23 | 4.41 |
| Making mounds and digging ridges across slopes | 260 | 93.19 | 155 | 82.89 | 54 | 96.43 | 469 | 89.85 |
| **Use of irrigation technologies:** | | | | | | | | |
| Rainwater harvesting | 0 | 0.00 | 0 | 0.00 | 1 | 1.79 | 1 | 0.19 |
| Use of rivers/streams | 271 | 97.13 | 178 | 95.19 | 53 | 94.64 | 502 | 96.17 |
| Digging of well | 245 | 87.81 | 169 | 90.37 | 51 | 91.07 | 465 | 89.08 |
| Sinking of bore-hole | 14 | 5.02 | 5 | 2.67 | 2 | 3.57 | 21 | 4.02 |

*Multiple responses

This indicates that the respondents do not depend mainly on rice production; they also produce other crops to prevent a total failure of rice as a result of changes in climate. Not only are different crops grown, the respondents also carefully select the varieties that are better in terms of yield, early maturity, drought tolerance and resistance to pests and diseases. These are put into practice to adapt to climate change.

### 5.10.2 Soil conservation

Soil conservation for this study involvesmulching, planting of cover crops, planting of trees, moderate use of fertilizers, moderate use of chemicals and use of organic manure. Mulching was used by about 45% in Kebbi State, 17% in Sokoto State, 36% in Zamfara State and 34% of the respondents all together.Planting of cover crops was used by 34% in Kebbi State, 20% in Sokoto State, 38% in Zamfara State and 29% of the respondentscollectively.Also, about41% of the respondents, with 50% in Kebbi State, 34% in Sokoto State and 20% in Zamfara State used planting of trees.

Majority of the respondents, about92% in Kebbi State, 96% in Sokoto State and 89% in Zamfara State applied the moderate use of fertilizers. Overall, 93% of them applied the moderate use of fertilizers. Similarly, majority of them, 90% in Kebbi State, 91% in Sokoto State and 88% in Zamfara State applied the moderate use of chemicals. Overall, 90% of them applied the moderate use of chemicals. In the same vein, majority (about99%) of the respondents, with the entire respondents (100%) in Kebbi State, 99% in Sokoto State and 98% in Zamfara State applied the use of manure (Table 5.8). This implies that the only aspects of soil conservation largely used by the farmers were moderate use of fertilizers, moderate use of chemicals and use of organic manure.

### 5.10.3 Adjusting the planting calendar

Adjusting the planting calendar involves early planting, late planting, early harvesting and late harvesting. Majority of the respondents, about97% in Kebbi State, 86% in Sokoto State and 93% in Zamfara State used early planting. Overall, about93% of them had used early planting. Similarly, majority of the respondents, 95% in Kebbi State, 89% in Sokoto State and 96% in Zamfara State used early harvesting.Overall, about 93% of them had used early harvesting.

Late planting was used by only about4% in Kebbi State, 14% in Sokoto State, 3% in Zamfara State and 7% of the respondents all together. Similarly, late harvesting was used by only about5% in Kebbi State, 11% in Sokoto State, 4% in Zamfara State and 7.% of the respondents all together (Table 5.8). This indicates that early planting and early harvesting were the main components of adjusting planting calendar used widely by the rice farmers.

### 5.10.4 Use of minimum tillage

Minimum tillage involveszero tillage and making mounds and digging ridges across slopes. Majority of the respondents, about93% in Kebbi State, 83% in Sokoto State and 96% in Zamfara State had used the practice of making mounds and ridges across slopes. Overall, about 90% of them had used the practice of making mounds and digging ridges across slopes. However, zero tillage was used by only about4% in Kebbi State, 6% in Sokoto State, none in Zamfara State and 4% of the respondents all together (Table 5.8). This indicates that making mounds and digging ridges across slopes was well used by the respondents in their efforts to adapt to climate change.

### 5.10.5 Use of irrigation technologies

This involvesthe use of rainwater harvesting, rivers/streams, digging of well and sinking of bore-hole to supply water to farmlands. The use of rivers/streams as sources of water was used by majority of the respondents, about97% of them in Kebbi State, 95% in Sokoto State and 95% in Zamfara State. Overall, 96% of them used rivers/streams as source of water for irrigation. Digging of wells for water supply was similarly used by majority (about89%) of the respondents, 88% of them in Kebbi State, 90% in Sokoto State and 91% in Zamfara State.

There was a very minimal use of rainwater harvesting and sinking of bore-holes among the farmers (Table 5.8).This implies that the farmers mainly used rivers/streams and dug wells for irrigation.This is contrary to the finding of Abaje *et al.* (2014) who reported that the most significant climate change adaptation strategies used by farmers were water harvesting, use of fertilizer/animals dung to improve soil moisture and prayers for God to intervene.

Ayanwuyi *et al.* (2010) reported that adaptation strategies actually adopted by the farmers in Ogbomosho Agricultural Zone of Oyo State, Nigeria were increase water conservation, shading and shelter/mulching, soil conservation and moving to different site. Other farmers implemented water conservation techniques, increased irrigation and increased or reduction in land size cultivated. They also reported that farmers adopted planting of different crops, treated seed with fungicides before sowing, planted different varieties of crops, practised mixed cropping and changed use of chemical. Furthermore, the respondents adopted change of row orientation with respect to slope and application of soil amendments e.g. farmyard manure, as the strategies to mitigate effect of climate change.

Adebayo *et al*. (2012) examined farmers' awareness, vulnerability and adaptation to climate change in Adamawa State, Nigeria and reported that farmers used seed tolerant varieties, altered their planting schedule, planted early maturing seed, used different tillage systems, and diversified their crops. They concluded that farmers adapted different adaptive measures to minimize the effect of climate change in the area.

Adesina *et al*. (2009) reported some indigenous adaptation strategies to climate variability by farmers to include fall back on previous harvest, rainwater harvesting,diversification of livelihoods and use of forecasts to prevent responding to false start of the rains. Other measures adopted by farmers included planting drought resistant crop varieties, social networking, migration to wetter regions and prayer for rain.

Farmers in the study area observed what has been described as technological adjustment, which is one of the four key features identified by Christoff, 1996 and Mol, 1996 to distinguish ecological modernization from other theoretical approaches. In spite of socioeconomic, institutional and technology based influences, the rice farmers used some environment friendly practices in their farming activities in order to adapt to changes in climate and improve their productivity. The farmers had transformed their production methods, which according to Glasson (2012) is an ecological modernizationthat transforms the threat of climate change into an opportunity, a new motor of neoliberal legitimacy.

### 5.10.6 Attributes of climate change adaptation practices

Among the attributes climate change adaptation practices are complexity and relative advantage. Moreover, affordability of the innovation by the farmers is of paramount importance. This section presents the findings on affordability, complexity and relative advantage of the climate change adaptation practices as the farmers learned to use over time.

The practices, as introduced earlier include portfolio diversification,which involves the use of improved rice varieties and intercropping; soil conservation, involvingmulching, planting of cover crops, planting of trees, moderate use of fertilizers, moderate use of chemicals and use of organic manure. Other practices are adjusting the planting calendar, involving early planting, late planting, early harvesting and late harvesting; use of minimum tillage involvingzero tillage and making mounds and ridges across slopes and use of irrigation technologies,involvingrainwater harvesting, use of rivers/streams, digging of well and sinking of bore-hole.

***Affordability of using climate change adaptation practices***

Affordability of using a climate change adaptation practice by a farmer is the perceived ability of the farmer to meet the financial obligation of the practice. Findingsof this study will be presented on affordability of portfolio diversification, soil conservation, adjusting the planting calendar, use of minimum tillage and use of irrigation technologies.

***Portfolio diversification***

Majority of the respondents, about91% in Kebbi State, 82% in Sokoto State and 75% in Zamfara State perceived that portfolio diversification,which involves the use of improved rice varieties and intercropping was affordable. Overall, about86% of the farmers perceived that portfolio diversification,which involves the use of improved rice varieties and intercropping was affordable. However, about12% of the respondents perceived that portfolio diversification was not affordable. Very few of them (about2%) were undecided (Table 5.9). This implies that portfolio diversification was perceived by the rice respondents as an affordable climate change adaptation practice and therefore had a chance of being used by the farmers.

***Soil conservation***

Soil conservation, which involvesmulching, planting of cover crops, planting of trees, moderate use of fertilizers, moderate use of chemicals and use of organic manure was perceived as affordable by majority of the respondents, about85% in Kebbi State, 92% in

Sokoto State and 86% in Zamfara State. In all, about85% of the farmers perceived soil conservation as an affordable practice. Only 19% of them perceived that soil conservation was not affordable, while 1% were undecided (Table 5.9). This indicates that as a climate change adaptation practice, soil conservation was perceived by the respondents as an affordable practice and therefore had a chance of being used.

***Adjusting the planting calendar***

Early planting, late planting, early harvesting and late harvesting are the sub-practices involved in adjusting the planting calendar in adapting to climate change. Majority of the respondents, about90% of them in Kebbi State, 91% in Sokoto State and 68% in Zamfara State perceived that adjusting the planting calendar was affordable. Overall, about88% of the farmers perceived that adjusting the planting calendar was affordable. However, about9% of them thought otherwise while 3% were undecided (Table 5.9). This indicates that the respondents perceived adjusting the planting calendar as an affordable climate change adaptation practice and therefore had a chance of being used.

***Use of minimum tillage***

Minimum tillage involveszero tillage and making mounds and digging ridges across slopes. Findings of this study show that majority of the respondents, about76% in Kebbi State, 68% in Sokoto State and 93% in Zamfara State perceived minimum tillage as an affordable practice. In all, 75% of the farmers perceived minimum tillage as an affordable practice. While 23% of the respondents felt otherwise, 3% of them were undecided (Table 5.9). This implies that the respondents perceived minimum tillage as an affordable climate change adaptation practice. It therefore had a good chance of being used.

*Use of irrigation technologies*

Use of irrigation technologiesinvolvesthe use rainwater harvesting, rivers/streams, digging of well and sinking of bore-hole. Majority of the respondents, about71% of them in Kebbi State, 63% in Sokoto State and 86% in Zamfara State perceived the use of irrigation technologies as an affordable practice. Overall, about70% of the respondents perceived the use of irrigationas an affordable practice. Only about29% of them perceived the use of irrigationas non affordable while 3% were undecided (Table 5.9). This implies that the respondents perceived the use of irrigation technologies as an affordable climate change adaptation practice. Hence, the chances of using irrigation, is high.

**Table 5.9: Distribution of respondents according to affordability of usingCCAP**

| Climate change adaptation practices | Kebbi State (n=279) | | Sokoto State (n=187) | | Zamfara State (n=56) | | Pooled Sample (n=522) | |
|---|---|---|---|---|---|---|---|---|
| | Freq | % | Freq | % | Freq | % | Freq | % |
| **Portfolio diversification** | | | | | | | | |
| Affordable | 254 | 91.04 | 154 | 82.35 | 42 | 75.00 | 450 | 86.21 |
| Not affordable | 21 | 7.53 | 30 | 16.04 | 10 | 17.86 | 61 | 11.69 |
| Undecided | 4 | 1.43 | 3 | 1.60 | 4 | 7.14 | 11 | 2.11 |
| **Soil conservation** | | | | | | | | |
| Affordable | 238 | 85.30 | 134 | 91.66 | 48 | 85.71 | 420 | 80.46 |
| Not affordable | 40 | 14.34 | 51 | 27.27 | 7 | 12.50 | 98 | 18.77 |
| Undecided | 1 | 0.36 | 2 | 1.07 | 1 | 1.79 | 4 | 0.77 |
| **Adjusting the planting calendar** | | | | | | | | |
| Affordable | 252 | 90.32 | 170 | 90.91 | 38 | 67.86 | 460 | 88.12 |
| Not affordable | 17 | 6.09 | 14 | 7.49 | 15 | 26.79 | 46 | 8.81 |
| Undecided | 10 | 3.58 | 3 | 1.60 | 3 | 5.36 | 16 | 3.07 |
| **Use of minimum tillage** | | | | | | | | |
| Affordable | 211 | 75.63 | 127 | 67.91 | 52 | 92.86 | 390 | 74.71 |
| Not affordable | 62 | 22.22 | 53 | 28.34 | 4 | 7.14 | 119 | 22.80 |
| Undecided | 6 | 2.15 | 7 | 3.74 | 0 | 0.00 | 13 | 2.49 |
| **Use of irrigation technologies** | | | | | | | | |
| Affordable | 197 | 70.61 | 118 | 63.10 | 48 | 85.71 | 363 | 69.54 |
| Not affordable | 79 | 28.32 | 66 | 35.30 | 6 | 10.71 | 151 | 28.93 |
| Undecided | 3 | 1.07 | 3 | 1.60 | 2 | 3.57 | 8 | 1.53 |

*Complexity of usingclimate change adaptation practices*

Complexity of using a climate change adaptation practice by a farmer is the perceived difficulty by the farmer to understand and use the practice. Results on complexity of portfolio diversification, soil conservation, adjusting the planting calendar, use of minimum tillage and use of irrigation technologies are presented in the following sub-titles:

***Portfolio diversification***

Majority of the respondents, 100% in Kebbi State, 98% in Sokoto State and 96% in Zamfara State perceived portfolio diversification, which involves the use of improved rice varieties and intercropping as a usable practice. Overall, about99% of the farmers perceived portfolio diversification as a usable practice (Table 5.10).

**Table 5.10: Distribution of respondents according to complexity of usingCCAP**

| | Kebbi State (n=279) | | Sokoto State (n=187) | | Zamfara State (n=56) | | Pooled Sample (n=522) | |
|---|---|---|---|---|---|---|---|---|
| **Climate Change Adaptation Practices** | **Freq** | **%** | **Freq** | **%** | **Freq** | **%** | **Freq** | **%** |
| **Portfolio Diversification** | | | | | | | | |
| Usable | 279 | 100.00 | 184 | 98.40 | 54 | 96.43 | 517 | 99.04 |
| Not usable | 0 | 0.00 | 3 | 1.60 | 2 | 3.57 | 5 | 0.96 |
| Undecided | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 0 | 0 |
| **Soil Conservation** | | | | | | | | |
| Usable | 268 | 96.06 | 180 | 96.26 | 54 | 96.43 | 502 | 96.17 |
| Not usable | 9 | 3.23 | 5 | 2.67 | 2 | 3.57 | 16 | 3.07 |
| Undecided | 2 | 0.72 | 2 | 1.07 | 0 | 0.00 | 4 | 0.78 |
| **Adjusting the planting calendar** | | | | | | | | |
| Usable | 269 | 96.42 | 178 | 95.19 | 50 | 89.29 | 497 | 95.21 |
| Not usable | 6 | 2.15 | 8 | 4.28 | 6 | 10.71 | 20 | 3.83 |
| Undecided | 4 | 1.43 | 1 | 0.53 | 0 | 0.00 | 5 | 0.96 |
| **Use of minimum tillage:** | | | | | | | | |
| Usable | 272 | 97.49 | 182 | 97.33 | 53 | 94.64 | 507 | 97.13 |
| Not usable | 6 | 2.15 | 5 | 2.67 | 0 | 0.00 | 11 | 2.11 |
| Undecided | 1 | 0.36 | 0 | 0.00 | 3 | 5.36 | 4 | 0.77 |
| **Use of irrigation technologies** | | | | | | | | |
| Usable | 270 | 96.78 | 153 | 81.82 | 49 | 87.50 | 472 | 90.42 |
| Not usable | 7 | 12.50 | 20 | 10.70 | 6 | 10.71 | 33 | 6.32 |
| Undecided | 2 | 0.72 | 4 | 2.14 | 1 | 1.79 | 7 | 1.34 |

This indicates that portfolio diversification was regarded by the respondents as a climate change adaptation practice not too difficult to understand and be used. The farmers are therefore very likely to use it as a climate change adaptation practice.

***Soil conservation***

Result of this study shows that majority of the respondents, 96% of them in Kebbi State, 96% in Sokoto State and 96% in Zamfara State perceived soil conservation, which involvesmulching, planting of cover crops, planting of trees, moderate use of fertilizers, moderate use of chemicals and use of organic manure as a usable practice. Overall, about96% of the farmers perceived soil conservation as a usable practice. Only 3% of them perceived that soil conservation was not usable, while 1% of them were undecided (Table 5.10). This implies that just like portfolio diversification, soil conservation was also regarded by the respondents as a climate change adaptation practice not too difficult to understand and be used.

***Adjusting the planting calendar***

Majority of the respondents, about96% of them in Kebbi State, 95% in Sokoto State and 89% in Zamfara State perceived that adjusting the planting calendar, involving early planting, late planting, early harvesting and late harvesting, was usable. Therefore, about95% of the respondents perceived that adjusting the planting calendar was a usable practice. However, 4% of them thought otherwise while 3% were undecided (Table 5.10). This implies that adjusting the planting calendar was regarded by the respondents as a climate change adaptation practice not too difficult to understand and be used. Its chance of being used by the farmers, therefore, is high.

***Use of minimum tillage***

Findings of this study also reveal that majority of the respondents, 98% of them in Kebbi State, 97% in Sokoto State and 94.64% in Zamfara State perceived minimum tillage, involvingzero tillage and making mounds and digging ridges across slopes as a usable practice. Overall, 97% of the respondents perceived minimum tillage as a usable practice. Only 2% of the respondents felt otherwise, while 1% of them were undecided (Table 5.10). This implies that the respondents perceived minimum tillage as a usable climate change adaptation practice. Hence, it had a good chance of being used.

***Use of irrigation technologies***

Table 5.15 also shows that majority of the respondents, about97% of them in Kebbi State, 82% in Sokoto State and 88% in Zamfara State perceived the use of irrigation technologies, involvingrainwater harvesting, use of rivers/streams, digging of well and sinking of bore-hole as a usable practice. Overall, about90% of the farmers perceived the use of irrigation technologiesas a usable practice (Table 5.10). Only 6% of them perceived the use of irrigation technologies as non usable while 1% were undecided. This implies that the rice farmers perceived the use of irrigation technologies as a usable climate change adaptation practice. Hence, the chance of its use is high.

***Relative advantage of using climate change adaptation practices***

Relative advantage of using a climate change adaptation practice reflects on how the practice is subjectively perceived as superior to the previous idea. Study finding on the relative advantage of using portfolio diversification, soil conservation, adjusting the planting calendar, using of minimum tillage and use of irrigation technologies is presented below.

***Portfolio diversification***

Majority of the respondents, about99% in Kebbi State, 97% in Sokoto State and 89% in Zamfara State perceived portfolio diversification as a favourable practice. Overall, about97% of the respondents perceived portfolio diversification as a favourable practice. Only 2% of the farmers perceived irrigation as unfavourable while 1% were undecided (Table 5.11). This implies that portfolio diversification was regarded by the respondents as a favourable climate change adaptation practice. The farmers are therefore very likely to use it as a climate change adaptation practice.

***Soil conservation***

Study findings show that majority of the respondents, about96% of them in Kebbi State, 82% in Sokoto State and 84% in Zamfara State perceived soil conservation as a favourable practice. In all, about90% of the farmers perceived soil conservation as a favourable practice. However, 8% of them perceived it as an unfavourable practice, while 2% of them were undecided (Table 5.11). This implies that just like portfolio diversification, soil conservation was also regarded by the respondents as a favourable climate change adaptation practice. Its chance of being used by the farmers will therefore be high.

***Adjusting the planting calendar***

Majority of the respondents, about92% of them in Kebbi State, 84% in Sokoto State and 73% in Zamfara State perceived that adjusting the planting calendar was a favourable practice. Overall, about87% of the farmers perceived that adjusting the planting calendar was a favourable practice. Only 10% of them thought otherwise while 3% were undecided (Table 5.11). This implies that adjusting the planting calendar was regarded by the respondents as a favourable climate change adaptation practice. Its chance of being used by the farmers is also high.

***Use of minimum tillage***

Study findings also reveal that majority of the respondents, about93% of them in Kebbi State, 95% in Sokoto State and 93% in Zamfara State perceived minimum tillage as a favourable practice. Overall, about94% of the farmers perceived minimum tillage as a favourable practice. Only 6% of the farmers felt otherwise, while 1% of them were undecided (Table 5.11). This implies that the respondents perceived minimum tillage as a favourable climate change adaptation practice. Hence, it had a good chance of being used.

***Use of irrigation technologies***

Study finding further reveals that majority of the respondents, about97% of them in Kebbi State, 97% in Sokoto State and 93% in Zamfara State perceived the use of irrigation technologies as a favourable practice. Overall, about96% of the farmers perceived the use of irrigation technologies as a favourable practice. Very few (about6%) of the respondents perceived the use of irrigation technologies as an unfavourable practice, while 0.4% of them were undecided (Table 5.11). This indicates that the respondents perceived the use of irrigation technologies as a favourable climate change adaptation practice. Hence, the chance of its being used is also high.

**Table 5.11: Distribution of respondents according to relative advantage of using CCAP**

| Climate Change Adaptation Practices | Kebbi State (n=279) | | Sokoto State (n=187) | | Zamfara State (n = 56) | | Pooled Sample (n=522) | |
|---|---|---|---|---|---|---|---|---|
| | **Freq** | **%** | **Freq** | **%** | **Freq** | **%** | **Freq** | **%** |
| **Portfolio Diversification** | | | | | | | | |
| Favourable | 276 | 98.93 | 181 | 96.79 | 50 | 89.29 | 507 | 97.13 |
| Unfavourable | 0 | 0.00 | 6 | 3.21 | 6 | 10.71 | 12 | 2.30 |
| Undecided | 3 | 1.07 | 0 | 0.00 | 0 | 0.00 | 3 | 0.58 |
| **Soil Conservation** | | | | | | | | |
| Favourable | 269 | 96.42 | 154 | 82.35 | 47 | 83.93 | 470 | 90.04 |
| Unfavourable | 6 | 2.15 | 31 | 16.58 | 7 | 12.50 | 44 | 8.43 |
| Undecided | 4 | 1.43 | 2 | 1.07 | 2 | 3.57 | 8 | 1.53 |
| **Adjusting the planting calendar** | | | | | | | | |
| Favourable | 257 | 92.11 | 157 | 83.96 | 41 | 73.21 | 455 | 87.17 |
| Unfavourable | 21 | 7.53 | 25 | 13.37 | 8 | 14.29 | 54 | 10.35 |
| Undecided | 1 | 0.36 | 5 | 2.67 | 7 | 12.50 | 13 | 2.49 |
| **Use of minimum tillage** | | | | | | | | |
| Favourable | 260 | 93.19 | 177 | 94.65 | 52 | 92.86 | 489 | 93.68 |
| Unfavourable | 19 | 6.81 | 10 | 5.35 | 0 | 0.00 | 29 | 5.56 |
| Undecided | 0 | 0.00 | 0 | 0.00 | 4 | 7.14 | 4 | 0.77 |
| **Use of irrigation technologies** | | | | | | | | |
| Favourable | 270 | 96.78 | 181 | 96.79 | 52 | 92.86 | 503 | 96.37 |
| Unfavourable | 8 | 2.87 | 5 | 2.67 | 4 | 7.14 | 17 | 3.26 |
| Undecided | 1 | 0.36 | 1 | 0.53 | 0 | 0.00 | 2 | 0.38 |

## 5.11 Perceived Effects of Climate Change on Rice Production

Results of this study revealed that among the farmers' perceived effects of climate change on rice production, climate change posing risks to rice production had the highest mean of 2.16 among the respondents. Specifically, it had the mean of 2.26 in Kebbi State, 2.18 in Sokoto State and 2.05 in Zamfara State. This was followed by the perception that climate change would lower rice production having an overall mean score of 2.07, with specific scores of 2.22, 2.15 and 1.84 in Kebbi State, Sokoto State and Zamfara State, respectively. The belief among the respondents that climate change would continue to affect storage of rice had an overall mean score of 2.01. It specifically had the mean scores of 2.20, 2.08 and 1.76 in Kebbi State, Sokoto State and Zamfara State, respectively (Table 5.12).

Climate change presenting more risks than benefits to rice production scored an overall mean of 1.87. It had mean scores of 2.14, 1.79 and 1.67 in Kebbi State, Sokoto State and Zamfara State, respectively. Continuous rise in annual temperature reducing production of rice scored an overall mean of 1.79, with specific mean scores of 1.88, 1.85 and 1.63 in Kebbi State, Sokoto State and Zamfara State, respectively. Next in the ranks was infestation of rice by pests being common due to climate change, with an overall mean of 1.77 and specific mean scores of 1.91, 1.81 and 1.60 in Kebbi State, Sokoto State and Zamfara State, respectively (Table 5.12).

With the mean score of at least 1.5 out of the possible 3.00, it indicates that majority of the respondents had a positive perception of climate change effects on rice production. In other words, they believed that climate change can impact negatively on rice production. Such perception or belief can motivate the farmers to take action within their context, thereby favouring the use of climate change adaptation practices. Adebayo *et al.* (2012) reported that majority of farmers in Adamawa State claimed that climate change has affected farming activities in recent years.

According to Haddad (2005) one factor that has almost been entirely omitted by majority of researchers is perception. How can one adapt to climate change adequately if he does not perceive the current and future climate change as a reality? It is reasonable to argue that the first step towards adaptation is the perception of the problem. However, research on the adaptation of small-scale farmers in Nigeria has often occurred in the absence of knowledge of rural farmers' perception about climate change, its causes and impact, as well as existing adaptation responses (Falaki *et al.,* 2013).

**Table 5.12: Distribution of respondents according to perceived effects of climate change on rice production**

| Perceived effects of Climate Change | Kebbi State (n = 279) Mean | Sokoto State (n=187) Mean | Zamfara State (n=56) Mean | Pooled Sample (n = 522) Mean |
|---|---|---|---|---|
| Climate change poses risks to rice production | 2.26 | 2.18 | 2.05 | 2.16 |
| Climate change presents more risks than benefits to rice production | 2.14 | 1.79 | 1.67 | 1.87 |
| Continuous rise in annual temperature reduces production of rice | 1.88 | 1.85 | 1.63 | 1.79 |
| Yearly rains are not supporting rice production as before | 2.08 | 1.57 | 1.51 | 1.72 |
| Infestation of rice by pest is common due to climate change | 1.91 | 1.81 | 1.60 | 1.77 |
| Climate change reduces working hours of rice farmers | 1.89 | 1.41 | 1.56 | 1.62 |
| There is poor germination rate of rice due to climate change | 1.96 | 1.72 | 1.78 | 1.82 |
| Climate change will lower rice production | 2.22 | 2.15 | 1.84 | 2.07 |
| Climate change will continue to affect storage of rice | 2.20 | 2.08 | 1.76 | 2.01 |

## 5.11.1 Rice production

Rice production for this study consists of information on rice output, yield, cropping system, habitat and water supply.

### 5.11.2 Rice output

Rice output refers to the quantity of paddy cultivated by a farmer. Majority (about79.12%) of the farmers, with 70% in Kebbi State, 91% in Sokoto State and 84% in Zamfara State produced between 5,000 and 5,999 kilogrammes (kg) of rice. About 11% of the farmers, 13%, in Kebbi State, 7% in Sokoto State and 16% in Zamfara State produced within the range of 6,000-10,999 kg of rice. Very few of the farmers (about5%) produced more than 10,999 kg of paddy. The overall mean was 4382.68 kg and the specific mean was 5582.98 kg in Kebbi State, 3490.51kg in Sokoto State and 4074.55 kg in Zamfara State (Table 5.13). This implies that majority of the farmers produced rice within the range of 5,000-5,999 kg.

**Table 5.13: Distribution of the rice farmers according to rice production**

| Variable | Kebbi State (n=279) | | Sokoto State (n=187) | | Zamfara State (n=56) | | Pooled Sample (n=522) | |
|---|---|---|---|---|---|---|---|---|
| | Freq | % | Freq | % | Freq | % | Freq | % |
| **Rice output (kg)** | | | | | | | | |
| Less than 1000 | 26 | 9.32 | 0 | 0.00 | 0 | 0.00 | 26 | 4.98 |
| 1000-5999 | 196 | 70.25 | 170 | 90.91 | 47 | 83.93 | 413 | 79.12 |
| 6000-10999 | 37 | 13.26 | 13 | 6.95 | 9 | 16.07 | 59 | 11.30 |
| More than 10999 | 20 | 7.17 | 4 | 2.14 | 0 | 0.00 | 24 | 4.60 |
| **Mean rice output** | | **5582.98** | | **3490.51** | | **4074.55** | | **4382.68** |
| **Rice yield (kg/ha)** | | | | | | | | |
| Less than 1500 | 6 | 2.15 | 0 | 0.00 | 0 | 0.00 | 6 | 1.15 |
| 1500-3499 | 63 | 22.58 | 90 | 48.14 | 9 | 15.77 | 162 | 31.03 |
| 3500-5499 | 189 | 53.74 | 67 | 45.83 | 24 | 42.85 | 280 | 53.64 |
| More than 54999 | 21 | 7.53 | 30 | 16.04 | 23 | 41.07 | 74 | 14.18 |
| **Mean rice yield** | | **3954.22** | | **3623.73** | | **5080.45** | | **4219.47** |
| **Rice cropping system** | | | | | | | | |
| Sole | 279 | 100.00 | 187 | 100.00 | 54 | 96.43 | 520 | 99.62 |
| Mixed | 0 | 0.00 | 0 | 0.00 | 2 | 3.57 | 2 | 0.38 |
| **Rice habitat** | | | | | | | | |
| Dry Upland | 24 | 8.60 | 25 | 13.37 | 3 | 5.36 | 52 | 9.96 |
| Waterlogged/Lowland | 149 | 53.41 | 140 | 74.87 | 50 | 89.29 | 339 | 64.94 |
| Both | 106 | 37.99 | 22 | 11.76 | 3 | 5.36 | 131 | 25.10 |
| **Water source** | | | | | | | | |
| Rainfall | 125 | 44.80 | 23 | 12.30 | 37 | 66.07 | 185 | 35.44 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Irrigation | 0 | 0.00 | 0 | 0.00 | 5 | 8.93 | 5 | 0.96 |
| Both | 154 | 55.20 | 164 | 87.70 | 14 | 25.00 | 332 | 63.60 |

### 5.11.3 Rice yield

Rice yield is a more standardized measure of rice quantity than output. Yield takes into consideration, the land size. In other words, it the quantity of rice produced per unit area. It is measured in kilogramme per hectare (kg/ha). When the rice output was divided by the land area cultivated, the results show that about54% of the farmers, 54% in Kebbi State, 46% in Sokoto State and 43% in Zamfara State had their yields within the range of 3500-5499 kg/ha. About 31% of the farmers, 23%, in Kebbi State, 48% in Sokoto State and 16% in Zamfara State had their yields within the range of 1500-3499 kg/ha. Those (about14%) who had more than 5499 kg/ha yield were generally minimal. The overall average was 4219.47 kg/ha and the specific average was 3954.22 kg/ha in Kebbi State, 3623.93 kg/ha in Sokoto State and 5080.45 kg/ha in Zamfara State (Table 5.13). This implies that the yield of rice, attained by most of the farmers was within the range of 3500-5499 kg/ha.

### 5.11.4 Rice cropping system

Cropping system for this study refers to rice produced either as a sole crop or mixed with other crops. Majority (99.6%) of the farmers, with 100% in both Kebbi and Sokoto States and 96% in Zamfara State produced rice as a sole crop (Table 5.13). This implies that rice is produced by the farmers as a sole crop.

### 5.11.5 Rice habitat

Majority (about65%) of the farmers, 54% in Kebbi State, 75% in Sokoto State and 89% in Zamfara State produced rice under waterlogged/lowland conditions. Also, about25% of the farmers, with larger proportion (38%) of them in Kebbi State produced in both waterlogged/lowland dry upland conditions (Table 5.13). This indicates that rice is largely produced under waterlogged/lowland conditions in the study area.

### 5.11.6 Water source

Study findings reveal that majority (about64%) of the farmers, 55% in Kebbi State, 880% in Sokoto State and 25% in Zamfara State relied on both rainfall and irrigation for supply of water to their growing rice. About 35% of the farmers, 45%, in Kebbi State, 12% in Sokoto State and 66% in Zamfara State relied mainly on rainfall as source of water for rice production (Table 5.13). This indicates that both rainfall and irrigation are used by the farmers as sources of water for rice production.

### 5.11.7 Relationship between perceived effects of climate changeand rice yield

Result on Table 5.14 shows the relationship between farmers' perceived effects of climate change on rice production and rice yield. There is a significant ($p<0.00$)relationship between farmers' perceived effects of climate change on rice production and rice yield in the three States with a chi-square value of 272.6368. This result is similar for each of the States with chi-square values of 207.6015, 113.7748 and 20.6431 for Kebbi State, Sokoto State and Zamfara State, respectively. This implies the existence of strong relationship between the rice farmers' perceived effects of climate change on rice production and rice yield. Hence, the null hypothesis is rejected. Positive perception therefore can lead to application of climate change adaptation practices, which will in turn lead to higher yields.

**Table 5.14: Relationship between perceived effects of climate change and rice yield**

| | Df | Value | Prob. |
|---|---|---|---|
| Kebbi State | 4 | 207.6015 | 0.000*** |
| Sokoto State | 4 | 113.7748 | 0.000*** |
| Zamfara State | 4 | 20.6431 | 0.000*** |
| Pooled Data | 4 | 272.6368 | 0.000*** |

***Significant at 1% level

### 5.11.8 Relationship between factors influencing the use of climate change adaptation practices and perceived effects of climate change on rice production

A number of variables like socio-demographic and socio-economic factors or ideological orientations influence perception and the mental picture of climate change (Stedman 2004; Sjöberg 1995). This study,therefore,estimated the factors that influence rice farmers' perceived effect of climate change on rice production. Table 5.15 presents linear regression estimates for determinants of perception and perceived effect of climate change on rice production. With reference to the overall fit of the regression model, the obtained $R^2$ (0.8664) and $R^2$ adjusted (0.8572) suggests that the weighted combination of the predictor variables was jointly significant in explaining each of the dependent variables.

**Table 5.15: Factors influencing use of CCAP and perceived effects of climate change on rice production in North-West, Nigeria**

| Variable | Coefficient | Standard error | t-ratio | P[\|T\|>t] |
|---|---|---|---|---|
| Constant | 5.165622 | .790263 | 6.54 | 0.000 |
| Age | .0010737 | .0030639 | 0.35 | 0.726 |
| Sex | -.8655824 | .0836575 | -10.35 | 0.000*** |
| Household size | -.0068441 | .0033084 | -2.07 | 0.040** |
| Years of acquiring formal Education | .0679474 | .0041924 | 16.21 | 0.000*** |
| Faming experience | -.0108659 | .0031397 | -3.46 | 0.001*** |
| Farm size | -.0355542 | .0394834 | -0.90 | 0.369 |
| Rice income | 1.36e-07 | 1.14e-07 | 1.20 | 0.231 |
| Off-farm employment | .1235276 | .0580493 | 2.13 | 0.034** |
| Weather information | -.067155 | .0236541 | -2.84 | 0.005*** |
| Climate change awareness | -.1344556 | .0729364 | -1.84 | 0.066* |
| Credit accessed | -1.71e-07 | 3.69e-07 | -0.46 | 0.644 |
| Extension contact | .0265562 | .0135678 | 1.96 | 0.051* |
| Years of cooperative membership | .0052883 | .0031142 | 1.70 | 0.091* |
| Affordability of using CCAP | .0320443 | .0075805 | 4.23 | 0.000*** |

| | | | | |
|---|---|---|---|---|
| Complexity of using CCAP | -.0777233 | .0093856 | -8.28 | 0.000*** |
| Relative advantage of using CCAP | -.0061227 | .0111214 | -0.55 | 0.582 |
| R-squared = 0.8664 | | | | |
| Adjusted R-squared = 0.8572 | | | | |
| F-ratio = 0.0000 | | | | |

***Significant at 1% level **Significant at 5% level
*Significant at 10% level

***Sex***

The result reveals that sex of the rice farmer negatively (p<0.01)and significantly influences farmers' perceived effect of climate change on rice production.The null hypothesis is therefore rejected. This implies that there was higher perception of climate change effect on rice production among female farmers than their male counterparts (Table 5.15). They may not necessarily employ more adaptation strategies than male farmers but findings of this study indicate that the female farmers had higher perception of climate change having negative effects on rice production.

***Household size***

Household size was also found to negatively and significantly (p<0.05)influence the rice farmers' perceived effect of climate change on rice production. The null hypothesis is therefore rejected.This implies that as the household size increases, the rice farmers' perceived effect of climate change on rice production decreases (Table 5.15). Larger family size therefore negatively conditions the ability of farmers to develop a favourable perception of climate change effect on rice production.

***Years of acquiring formal education***

These findings suggest that education positively and significantly (p<0.00)influences farmers' perceived effect of climate change on rice production (Table 5.15). Hence, the null hypothesis is rejected. This may be explained by a high level of awareness (general appreciation of benefits of adapting to climate change) and access to adaptation information common with educated farmers (Taruvinga *et al.*, 2016).

***Faming experience***

Result of this study further reveals that farming experience negatively and significantly($p<0.01$)influences farmers' perceived effect of climate change on rice production (Table 5.15).The null hypothesis is therefore rejected.This indicates that increase in years of farming decreases the rice farmers' perceived effect of climate change on rice production.

***Off-farm employment***

Off-farm employment is statistically significant($p<0.05$). It also has a positive coefficient (Table 5.15). Hence, the null hypothesis is rejected.Off-farm employment therefore has a positive and significant influence on farmers' perceived effect of climate change on rice production. This indicates that rice farmers who had off-farm employment had higher perception of climate change effect on rice production than those without off-farm employment.

***Weather information***

Weather information is also statistically significant ($p<0.01$)but with a negative coefficient. The null hypothesis is therefore rejected. It therefore has a negative and significant influence on farmers' perceived effect of climate change on rice production. It implies that the more the farmers acquire information on weather, the less their perception of climate change effect on rice production (Table 5.15).

***Climate change awareness***

Climate change awareness was also found to negatively and significantly ($p<0.10$)influence the rice farmers' perceived effect of climate change on rice production. The null hypothesis is therefore rejected. This implies that as the climate change awarenessof the farmers'increases, theirperception of climate change effect on rice production decreases (Table 5.15). This, perhaps, is due to the confidence they develop after using the climate change adaptation practices which improves rice production.

***Extension contacts***

Extension contacts positively and significantly ($p<0.10$)influence farmers' perceived effect of climate change on rice production (Table 5.15). The null hypothesis is therefore rejected. This implies that the rice farmers' perceived effect of climate change on rice production will increase with increase in extension contact. This reveals the relevance of extension work in updating the farmers' knowledge of the adverse effects of climate change on rice production.

***Years of cooperatives membership***

Table 5.15further reveals thatyears of cooperatives membership positively and significantly ($p<0.10$)influence farmers' perceived effect of climate change on rice production. This implies that farmers' perceived effect of climate change on rice production increases with increase in number of years in the cooperative societies. The null hypothesis is therefore rejected. Membership of cooperative society therefore plays a significant role in both enlightening and empowering the famers leading to a positive perception of the effects of climate change on rice production.

***Affordability of usingclimate change adaptation practices***

Perceived affordabilityof using climate change adaptation practices was also found to statistically ($p<0.01$)and positively influence the farmers' perceived effect of climate change on rice production (Table 5.15).The null hypothesis is therefore rejected. This implies that perceived affordability of using the climate change adaptation practices is highly controlled by the farmers' perceived effect of climate change on rice production.

***Complexity of using climate change adaptation practices***

Perceived complexity of using climate change adaptation practices is also statistically significant ($p<0.01$) but with a negative coefficient (Table 5.15). Hence, the null hypothesis is rejected. It therefore has a negative and significant influence on farmers' perceived effect of climate change on rice production. It implies that the more the farmers perceived the climate change adaptation practices as being complex to be used, the less their perception of climate change effect on rice production.

De Jonge (2010) used multiple regression model to analyse data from irrigators and found that age, education level, district where they carry out farming activities, influence farmers' perceptions and their ability to adapt to climate change.

## 5.12 Effect of Farmers' Use of Climate Change Adaptation Practices on their Level of Living

This section analyzed the rice farmers' level of living through the amount of rice income spent on acquiring assets. It also determined the relationship between farmers' use of climate change adaptation practices and their level of living.

### 5.12.1 Level of living of rice farmers

Rice farmers' level of living was analyzed in terms of estimated amount of money spent on assets acquired after the production season under review (2015). The assets included vehicles, electronics and land and housing. Assets consideration for assessing the farmers' level of living is in line with Moser and Felton (2007) who showed that households that have few assets (the structurally poor) but benefit from an income above the poverty line (stochastically non-poor) are particularly vulnerable to climate change impacts.Asset ownership is often used as a key welfare indicator.Asset acquisition may reflect animprovement in livingstandards and vice versa.According to Ravallion and Bidami (2001) increasing access to assets is crucial for broad-based growth and povertyreduction.

***Estimated amount spent on acquiring vehicles***

This involves amount spent on purchases and maintenance of bicycles, motorcycles and automobiles. About 49% of the rice farmers did not spend any part of their rice income on vehicles. Among those who spent part of their rice income on vehicles, about48% had spent within ₦5,000-₦126,999, with 39% of them in Kebbi State, 59% in Sokoto State and57% in Zamfara State. Only about2% and 1% of the farmers spent within ₦127,000-₦248,999 and ₦249,000-₦370,999 on vehicles, respectively (Table 5.16). This indicates that many of the farmers had spent part of their rice income on purchase of vehicles.

***Estimated amount spent on acquiring electronics***

Some amount of money was also spent on electronics mostly for domestic use. The electronics are radio, television set, DVD player, satellite receiver/decoder, handset etc. About 46% of the rice farmers did not spend any part of their rice income on electronics. Among those who spent part of their rice income on electronics, 45% had spent within ₦800-₦31,2999, with 39% of them in Kebbi State, 52% in Sokoto State and55% in Zamfara State. Only 7% and 1% of the farmers spent within ₦31,300-₦61,799 and ₦61,800-₦92,2999 on electronics, respectively (Table 5.16). This implies that many of the farmers had also spent part of their rice income on electronics

***Estimated amount spent on land and housing***

Expenditure on land and housing involves purchase of land and building of house (completed or under construction). Majority (about86%) of the rice farmers did not spend any part of their rice income on land and housing. Among those who spent part of their rice income on land and housing, 9.00% had spent within ₦4,000-₦36,999, with 8% of them in Kebbi State, 5% in Sokoto State and 27% in Zamfara State. Only 4% and 1% of the farmers spent within ₦37,000-₦69,999 and ₦70,000-₦102,999 on land and housing, respectively (Table 5.16). This implies that very few of the farmers spent part of their rice income on land and housing.

**Table 5.16: Distribution of rice farmers according to their level of living**

| Estimated values of assets acquired (₦) | Kebbi State (n=279) | | Sokoto State (n=187) | | Zamfara State (n=56) | | Pooled Sample (n=522) | |
|---|---|---|---|---|---|---|---|---|
| | Freq | % | Freq | % | Freq | % | Freq | % |
| **Estimated amount spent on vehicles** | | | | | | | | |
| None | 159 | 56.99 | 74 | 39.57 | 24 | 42.86 | 257 | 49.23 |
| 5000-126999 | 108 | 38.71 | 110 | 58.82 | 32 | 57.14 | 250 | 47.89 |
| 127000-248999 | 11 | 3.94 | 0 | 0.00 | 0 | 0.00 | 11 | 2.11 |
| 249000-370999 | 1 | 0.36 | 3 | 1.61 | 0 | 0.00 | 4 | 0.77 |
| **Estimated amount spent on electronics** | | | | | | | | |
| None | 141 | 50.54 | 82 | 43.85 | 19 | 33.93 | 242 | 46.36 |
| 800-31299 | 109 | 39.07 | 98 | 52.41 | 30 | 53.57 | 237 | 45.40 |
| 31300-61799 | 26 | 9.32 | 5 | 2.67 | 6 | 10.71 | 37 | 7.09 |
| 61800-92299 | 3 | 1.08 | 2 | 1.07 | 1 | 1.79 | 6 | 1.15 |
| **Estimated amount spent on** | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **land and housing** | | | | | | | | |
| None | 245 | 87.81 | 170 | 90.91 | 36 | 64.29 | 451 | 86.40 |
| 4000-36999 | 22 | 7.89 | 10 | 5.35 | 15 | 26.79 | 47 | 9.00 |
| 37000-69999 | 10 | 3.58 | 7 | 3.74 | 4 | 7.14 | 21 | 4.02 |
| 70000-102999 | 2 | 0.72 | 0 | 0.00 | 1 | 1.79 | 3 | 0.58 |

### 5.12.2 Relationship between use of climate change adaptation practices and level of living (value of assets acquired)

Relationship between farmers' use of climate change adaptation practices and their level of living was analyzed. The farmers' level of living was measured as the value of assets acquired by the rice farmers. The analysis revealed a significant ($p<0.00$) relationship between farmers' use of climate change adaptation practices and their level of living with a chi-square value of 258.6325. This implies the existence of a strong relationship between the rice farmers' use of climate change adaptation practices and their level of living. Hence, the null hypothesis, which states that there is no significant relationship between use of climate change adaptation practices and farmers' level of living, is rejected. Farmers should therefore utilize the climate change adaptation practices for improvement in their level of living.

## 5.13 Farmers' Attitude towards the Use of Climate Change Adaptation Practices

The most positive attitude was expressed by the respondents in the use of organic manure having a role to play in soil conservation to minimize the effect of climate change which had the mean scores of 4.20, 4.25 and 4.22 (all above the mid-point of 3.0) in Kebbi State, Sokoto State and Zamfara State, respectively, with an overall mean of 4.22(Table 5.17a)

The need for use of climate change adaptation practices and the use of improved rice varieties minimizing the effect of climate change on rice yield had mean scores of 4.09. The former had mean scores of 4.22, 3.91 and 4.15 in Kebbi State, Sokoto State and Zamfara State, respectively while the later had mean scores of 4.22, 3.99 and 4.09 in Kebbi State, Sokoto State and Zamfara State, respectively.

The rice farmers' personal view on digging of well and/sinking of bore-hole being important for production of irrigated rice had a mean score of 4.07, with specific mean scores of 4.04, 4.16 and 4.00 in Kebbi State, Sokoto State and Zamfara State, respectively. The respondents expressed a positive attitude on agreeing that early planting can minimize rice failure due to late season drought which minimizes the effect of climate change, with an overall mean of 4.06, with Kebbi State farmers scoring a mean of 4.12, Sokoto State scoring 4.01 and Zamfara State scoring 4.06. The farmers' personal opinion on three sets of views scored a mean of 4.05 each. The views are that early harvesting might be necessary to prevent the incidence of floods in rice fields caused by climate change, making mounds and digging ridges across slopes minimized erosions in the farm which minimized the effect of climate change and the use of rivers/streams made it possible for rice production during dry season.

**Table 5.17a: Distribution of respondents according to farmers' attitude to use of CCAP**

| | **Attitudinal indicators** | **Kebbi State (n= 279) Mean** | **Sokoto State (n=187) Mean** | **Zamfara State (n = 56) Mean** | **Pooled Sample (n= 522) Mean** |
|---|---|---|---|---|---|
| i. | There is need for use of climate change adaptation practices | 4.22 | 3.91 | 4.15 | 4.09 |
| ii. | Use of improved rice varieties can minimize the effect of climate change on rice yield | 4.22 | 3.99 | 4.06 | 4.09 |
| iii. | Intercropping is necessary to avoid total crop failure due to climate change | 4.11 | 3.99 | 3.89 | 4.00 |
| iv. | Mulching is an important practice for soil conservation to minimize the effect of climate change | 3.99 | 3.74 | 3.69 | 3.81 |
| v. | Planting of cover crops can help conserve soil to minimize the effect of climate change | 4.17 | 3.99 | 3.69 | 3.95 |
| vi. | Planting of trees such as *Acacia spp* can play a significant role in soil conservation which minimizes the effect of climate change | 3.98 | 3.71 | 3.67 | 3.79 |
| vii. | Moderate use of fertilizers has relationship with soil conservation in minimizing the effect of climate change | 4.12 | 3.98 | 3.91 | 4.00 |

| | | | | | |
|---|---|---|---|---|---|
| viii. | Moderate use of chemicals is essential for soil conservation to minimize the effect of climate change | 4.03 | 3.77 | 3.87 | 3.89 |
| ix. | Use of organic manure has a role to play in soil conservation to minimize the effect of climate change | 4.20 | 4.25 | 4.22 | 4.22 |

Majority of the respondents expressed positive views or attitudes since most of the mean scores expressed are greater than 3.00 (Table 5.17b). Just like their perception, this can also motivate the farmers to take action against the negative impacts of climate change on their productivity, thereby favouring the use of climate change adaptation practices.

**Table 5.17b: Distribution of respondents according to farmers' attitude to use of CCAP**

| Attitudinal indicators | | Kebbi State (n= 279) Mean | Sokoto State (n=187) Mean | Zamfara State (n = 56) Mean | Pooled Sample (n= 522) Mean |
|---|---|---|---|---|---|
| i. | Early planting can minimize rice failure due to late season drought which minimizes the effect of climate change | 4.12 | 4.01 | 4.06 | 4.06 |
| ii. | Late planting has relevance in avoidance of early season drought to minimize the effect of climate change | 1.99 | 1.99 | 1.96 | 1.98 |
| iii. | Early harvesting may be necessary to prevent the incidence of floods in rice fields caused by climate change | 4.16 | 4.04 | 3.95 | 4.05 |
| iv. | Late harvesting can minimize late season's erosions and floods caused by climate change | 2.22 | 2.32 | 2.62 | 2.39 |
| v. | Zero tillage is an important soil conservation technique to minimize the effect of climate change | 3.04 | 2.46 | 2.35 | 2.62 |
| vi. | Making mounds and digging ridges across slopes minimize erosions in the farm which minimizes the effect of climate change | 4.10 | 4.05 | 4.00 | 4.05 |
| vii. | Rainwater harvesting is a useful practice for saving water to minimize the effect of climate change | 3.82 | 4.09 | 3.82 | 3.91 |
| viii. | Use of rivers/streams makes it possible for rice production during dry season | 4.04 | 4.11 | 4.00 | 4.05 |
| ix. | Digging of wells and/ | 4.04 | 4.16 | 4.00 | 4.07 |

| | |
|---|---|
| | sinking of bore-holes are important for the production of irrigated rice |

### 5.13.1 Relationship between attitude of rice farmers and use ofclimate change adaptation practices

Attitude is an important determinant of usage. This study measures the relationship between attitude of the rice farmers to use of climate change adaptation practices and use of the practices. Result of the analysis shows a significant ($p<0.01$)relationship between attitude of the rice farmers to use of climate change adaptation practices and use of the practices with a chi-square ($x^2$) value of 12.7952. Specifically, there is a significant ($p<0.01$)relationship between farmers' attitude to use of climate change adaptation practices and use of the practices among rice farmers in Kebbi State, with a chi-square value of 28.1738 (Table 5.18). The null hypothesis is therefore rejected.

The relationship is similarly significant ($p<0.10$) among rice farmers in Sokoto State, with a chi-square value of 4.9933. However, the result indicated an insignificant relation in Zamfara State, with a chi-square value of 3.9842. Nevertheless, the null hypothesis which states that there is no significant relationship between attitude of the rice farmers and their use of climate change adaptation practices is rejected. This indicates that attitude of the rice famers is strongly associated with the farmers use of climate change adaptation practices.

**Table 5.18: Relationship between attitude of rice farmers and use of CCAP**

| | **Df** | **Value** | **Prob.** |
|---|---|---|---|
| Kebbi State | 2 | 28.1738 | 0.000*** |
| Sokoto State | 2 | 4.9933 | 0.082* |
| Zamfara State | 2 | 3.9842 | 0.136 |
| Pooled Data | 2 | 12.7952 | 0.002*** |

***Significant at 1% level *Significant at 10% level

## 5.14 Factors Influencing use of Climate Change Adaptation Practices by Rice Farmers

Results in Table 5.19 show that, years of formal education, farm size, climate change awareness, extension contact, years of cooperative membership and affordability of using climate change adaptation practices had a positive and significant influence on use of climate change adaptation practices among rice farmers in North-West, Nigeria. Similarly, sex, farming experience and weather information had a negative and significant influence on use of climate change adaptation practices among the farmers. Therefore, among the socioeconomic factors (age, sex, household size, years of formal education, faming experience, farm size, off-farm employment, rice income, climate change awareness weather information), sex, faming experience, years of formal education, farm size, weather information and climate change awareness were found to significantly influence the use of climate change adaptation practices among rice farmers in North-West, Nigeria.

Among the institutional factors (access to credit, extension contact and years of cooperative membership), extension contact and years of cooperative membership were also found to significantly influence the use of climate change adaptation practices among the rice farmers. Similarly, among the technology related attributes (affordability, complexity and relative advantage) only affordability was found to significantly influence the use of climate change adaptation practices among the rice farmers. The null hypothesis is therefore rejected.

The likelihood ratio statistic as indicated by chi-square statistic was highly significant ($P<0.00$), suggesting that the tobit regression model for the pooled data has a strong explanatory power (Table 5.19).

**5.14.1 Sex**

Sex is statistically significant ($p<0.10$) but has a negative coefficient (Table 5.19). This implies that the use of climate change adaptation practices among rice farmers in North-West was higher among male farmers than their female counterparts. This result agree with Iheke and Nwaru (2014) who reported that the higher rate of use by men has a bearing on the lopsidedness of extension services, the major means of innovation diffusion. Deressa *et al*. (2009) reported that male headed households were more likely to adopt climate risk coping strategies while Nhemachena and Nhem (2007) reported otherwise.

Food and Agriculture Organization (FAO) (2005) submitted that few extension services are targeted at rural women, few of the world's extension agents are women and most of the extension services focus on commercial rather than subsistence crops-the primary concern of women. Also, Omonona *et al.* (2005) and Mignouna *et al.* (2011) observed that gender affects technology adoption since the head of household is the primary decision maker and men have more access to and control over vital production resources than women due to socio-cultural values and norms.

### 5.14.2 Education

Education is statistically significant ($p<0.01$). The positive coefficient implies that education had a strong influence on the use of climate change adaptation practices (Table 5.19). An increase in the level of education would increase the probability of the farmer to use climate change adaptation practices. This implies that as rice farmers acquire more education, their probability of adapting to climate change increases. These results are in support of the findings of Deressa *et al.* (2009) who found a positive relationship between education and adaptation to climate change in Ethiopia.

De Jonge (2010) also found that farmers who have university education are more likely to respond to climate change than farmers who have primary education. Education increases the probability of utilizing adaptation measures because higher level of education is often hypothesized to increase the probability of using new technologies (Daberkow and McBride 2003; Gbetibouo, 2009), greater access to information on climate change and agricultural productivity (Deressa *et al*., 2011).

### 5.14.3 Farming experience

Farming experience is statistically significant ($p<0.05$) but has a negative sign and a p-value of 0.015 (Table 5.19). Increase in farming experience by one year therefore will decrease the probability of the farmer to use the climate change adaptation practices. Farming experience represents the number of years that the farmer has been into farming, it therefore increases with age. As the farmer grows older, he/she is likely to lose interest in the use of climate change adaptation practices.

Adesina and Zinnah (1993) mentioned that it is generally believed that as farmers grow older, they are less amenable to change from their old practices. Younger farmers are likely to use new innovation faster than the older ones. They are still in their active age, more receptive to innovation and could withstand the stress and strain involved in agricultural production and ease adaptation to climate change (Onubuogu and Esiobu, 2014). This is contrary to Hassan and Nhemachena (2007) who found that farmer's experience increases the probability of uptake of all adaptation options.

### 5.14.4 Farm size

Farm size is statistically significant ($p<0.05$). It has a positive coefficient which implies that farm size had a strong influence on use of climate change adaptation practices (Table 5.19). An increase in farm size would increase the probability of the farmer using climate change adaptation practices. This implies that as rice farmers acquire more farm land, their probability of adapting to climate change increases. Larger farm has higher chance of utilizing adaptation measures (Fatuase *et al.*, 2015). This connotes with several studies in the literature (Gbetibouo, 2009; Deressa *et al.*, 2011; Fatuase and Ajibefun, 2014).

The probable reason was in line with the report of Daberkow and McBride (2003) cited in Gbetibouo (2009) who opined that given the uncertainty and the fixed transaction and information costs associated with innovation, there may be a critical lower limit on farm size that prevents smaller farms from using several adaptations. As these costs increase, the critical size also increases. It follows that innovations with large fixed transaction and/or information costs are less likely to be used by smaller farms (Gbetibouo, 2009).

### 5.14.5 Weather information

As a factor, weather information was found to be statistically significant ($p<0.01$) with a negative coefficient and a p-value of 0.002 (Table 5.19). Increase in weather information therefore will decrease the probability of the farmer to use the climate change adaptation practices.

### 5.14.6 Climate change awareness

Climate change awareness is significant ($p<0.01$) with a positive coefficient indicating that climate change awareness had a strong influence on use of climate change adaptation practices (Table 5.19). If a farmer is exposed to information on climate change then his/her probability of using the climate change adaptation practices increases. This implies that more climate change information dissemination will increase the likelihood of farmers to use the climate change adaptation practices. Rice farmers who have access to information on climate change have a higher predicted probability of adapting to climate change than those without access. The results are consistent with findings of Deressa *et al.*(2009) and Hassan and Nhemachena (2008) who found information on climate change as significant in influencing farmers' adaptation choice.

### 5.14.7 Extension contacts

Extension contacts were found to be statistically significant ($p<0.01$). The coefficient is positive which implies that extension contact had a strong influence on use of climate change adaptation practices (Table 5.19). An increase in extension contact would increase the probability of the farmer using climate change adaptation practices. This implies that as rice farmers obtain more contacts with the extension agents, their probability of adapting to climate change increases.

Fatuase *et al.* (2015) found that access to extension agent was significant in influencing the rate of utilizing adaptation measures. They added that the more the farmer has access to extension services, the more the chance of utilizing many adaptation measures. This is because extension agents assist the farmers to make decisions that would guide them against the consequences of climate change and by exposing them to latest information and technical skills that will boast their crop production despite the changes in climate.

### 5.14.8 Cooperatives membership

Cooperatives membership is statistically significant ($p<0.01$) with a positive coefficient (Table 5.19). The positive coefficient implies that cooperative membership had a strong influence on use of climate change adaptation practices. An increase in the years of cooperative membership would increase the probability of the farmer using climate change adaptation practices. This implies that as rice farmers acquire more years in the cooperative societies, their probability of adapting to climate change increases. This is due to the role cooperative societies play in not only increasing the capital base of the farmers, but as an avenue to enlighten the farmers on the importance of using the climate change adaptation practices.

### 5.14.9 Affordability

Affordability of using climate change adaptation practices was also found to be statistically significant ($p<0.01$). The coefficient is positive which implies that affordability had a strong influence on use of climate change adaptation practices (Table 5.19). An increase in affordability would increase the probability of the farmer using climate change adaptation practices. This implies that as the affordability of the rice farmers increases, their probability of adapting to climate change would also increase. All the climate change adaptation practices have cost implications which limit the farmers' ability to use them. Farmers with higher capital base are more likely to employ the use of the adaptation practices.

**Table 5.19: Factors influencing the use of CCAP in by the respondents**

| Variable | Coefficient | Standard error | t-ratio | P[\|T\|>t] |
|---|---|---|---|---|
| Constant | .2272166 | .1606447 | 1.41 | 0.158 |
| Age | -.0001969 | .0006286 | -0.31 | 0.754 |
| Sex | -.0294055 | .0170122 | -1.73 | 0.085* |
| Household size | -.0000544 | .0006753 | -0.08 | 0.936 |
| Years of formal Education | .0082387 | .0008528 | 9.66 | 0.000*** |

| | | | | |
|---|---|---|---|---|
| Faming experience | -.0015696 | .0006412 | -2.45 | 0.015** |
| Farm size | .0187711 | .0080722 | 2.33 | 0.021** |
| Income from rice production | -1.51e-08 | 2.31e-08 | -0.66 | 0.513 |
| Off-farm employment | .0114669 | .0118226 | 0.97 | 0.333 |
| Weather information | -.0148115 | .0048410 | -3.06 | 0.002*** |
| Climate change awareness | .0751906 | .0148369 | 5.07 | 0.000*** |
| Credit accessed | -7.00e-08 | 7.51e-08 | -0.93 | 0.352 |
| Extension contact | .0099623 | .0027722 | 3.59 | 0.000*** |
| Years of cooperatives membership | .0033329 | .0006337 | 5.26 | 0.000*** |
| Affordability of using CCAP | .0056819 | .0015448 | 3.68 | 0.000*** |
| Complexity of using CCAP | .0012794 | .0019081 | 0.67 | 0.503 |
| Relative advantage of using CCAP | -.0006896 | .002261 | -0.31 | 0.761 |
| LR $chi^2(18)$ = 511.90000 | | | | |
| Prob > $chi^2$ = 0.00000 | | | | |
| Log likelihood = 491.24853 | | | | |
| Pseudo $R^2$= -1.08780 | | | | |

***Significant at 1% level **Significant at 5% level *Significant at 10% level

Apata *et al.* (2009) used logit regression model to analyse climate change perception and adaptation among arable food crop farmers in South Western Nigeria. They found that increased temperature, intercropping of cereals, mulching, zero tillage, making ridges, farm size, farm experience, education status of the farmer, access to extension services and credit facilities positively influence adaptation to climate change. They also found that change in timing of rains, use of heavy machines, and household size are also significant factors but influence adaptation negatively. Similarly, Deressa *et al.* (2009) found education, credit and extension services to positively influence climate change while household size had a negative effect.

Fosu-Mensah *et al.* (2010) analysed household survey dataset to study the farmers' perceptions and adaptation to climate in Sekyedumase District located in the Northern part of Ghana. They found that land tenure, soil fertility level, access to extension services, access to credit and community lived by the farmers were significant determinants to adapting to climate change. The study findings concur with those of Gbetibouo (2009) on variables such as land tenure, soil fertility, extension services and credit that influence the farmer to adapt to climate change.

Maddison (2006) also found that farming experience, extension advice about crop or livestock production and education of the household head increased the probability of the farmer adapting to climate change. Gbetibouo's (2009) findings indicated that household size, farming experience, wealth, access to credit, access to water, tenure rights, off farm activities, and access to extension services were the main factors that enhanced adaptive capacity of farmers to climate change.

**5.14.10Other variables**

The other variables included in the model were found to have no significantinfluence on farmers' use of climate change adaptation practices. They include age, marital status, household size and income. Others include credit accessed, relative advantage of using climate change adaptation practices, off-farm employment and complexity of using climate change adaptation practices. Age had a negative coefficient (p=0.754), marital status had a negative coefficient (p=0.456) and household size also had a negative coefficient (p=0.936).

Income from rice production had a negative coefficient (p=0.513), number of years of climate change awareness had a negative coefficient (p=0.518), credit accessed had a negative coefficient (p=0.352) and relative advantage of using climate change adaptation practices also had a negative coefficient (p=0.761). However, off-farm employment and complexity of using climate change adaptation practices both had positive coefficients with p-values of 0.333 and 0.503, respectively (Table 5.19).

### 5.15 Constraints to the Use of Climate Change Adaptation Practices

Constraints to use of climate change adaptation practices,as reported by the farmersincludelow income (about88% in Kebbi State, 83% in Sokoto State and 88% in Zamfara State). Overall, 86% of them reported low income as a constraint to use of climate change adaptation practices (Table 5.20).

Majority of the respondents, about86% in Kebbi State, 78% in Sokoto State and 88% in Zamfara State reported high cost of improved rice varieties as a constraint to use of climate change adaptation practices. Overall, 83% of them reported high cost of improved rice varieties as a constraint to use of climate change adaptation practices. Also,about77%of the respondents in Kebbi State, 86% in Sokoto State and 75% in Zamfara State were constrained by poor access to information relevant to adaptation.Overall, about80% of them were constrained by poor access to information relevant to adaptation. Non availability of processing facilities for value chain addition was also a constraint to majority of the respondents,70% in Kebbi State, 70% in Sokoto State and 63% in Zamfara State. In all, 80% of the respondents were constrained by non availability of processing facilities for value chain addition.

Other major constraints encountered by the farmers include low literacy level encountered by about75% of the respondents in Kebbi State, 67% in Sokoto State and 77% in Zamfara State. Overall, 72% of the farmers encountered low literacy level.Inadequate organic fertilizer was experienced by 53% of the respondents in Kebbi State, 52% in Sokoto State and 52% in Zamfara State, with an overall of about72%.Similarly, 72% of them, 76% in Kebbi State, 66% in Sokoto State and 75% in Zamfara State were constrained by inadequate financial resources.Inadequate knowledge on how to cope was experienced by 71% of the respondents, 72% of them in Kebbi State, 69% in Sokoto State and 68% in Zamfara State.

Table 5.20 further shows that majorityof the respondents, about70% in Kebbi State, 66% in Sokoto State and 64% in Zamfara State reported high cost of farm labour as a constraint to use of climate change adaptation practices.Overall, about68% of them reported high cost of farm labour as a constraint to use of climate change adaptation practices. High cost of constructing irrigation and drainage systems was a constraint to about64% of the respondents in Kebbi State, 67% in Sokoto State and 73% in Zamfara State.Overall, about66% of the farmers reported high cost of constructing irrigation and drainage systems as a constraint. Also, about72% in Kebbi State, 55% in Sokoto State and 70% in Zamfara State were constrained by poor response to climate change related issues. Overall, about66% of them were constrained by poor response to climate change related issues.

High cost of diversification of enterprise was also experienced by majority of the respondents, about67% in Kebbi State, 62% in Sokoto State and 68% in Zamfara State. In all, about65% of them experienced high cost of diversification of enterprise. Besides high cost of improved rice varieties, the respondents (about64%) also encountered limited access to the improved varieties, specifically by about62% in Kebbi State, 65% in Sokoto State and 68% in Zamfara State.

The respondents reported other important constraints to use of climate change adaptation practices including poor response to crises related to climate change (63%), inadequate government policies on climate change adaptation and mitigation (59%), inefficient water harvesting methods (57%),planting before rains resulting to crop failure (56%), high cost of land (56%) and poor extension services (55%) (Table 5.20). This indicates that the respondents experienced one constraints or the other in the use of climate change adaptation practices.

However, most of the constraints experienced by the respondents in adaptation to climate change were related to low income. Deressa (2008) reported that most of the constraints encountered by farmers in adaptation to climate change were associated with poverty. This is because poor and hungry farmers would naturally divert their limited farm income towards the basic necessities like feeding and medication rather than ploughing them into climate change adaptation measures.
Moreover, five major constraints to climate change adaptation experienced by farmers in the Nile basin of Ethiopia identified by Deressa (2010) were lack of information pertaining climate change, lack of money, shortage of labour and land and poor potential for irrigation. Similarly, in a study of climate change adaptation measures by crop farmers in the southeast rainforest zone of Nigeria, Onyeneke and Madukwe (2010) reported that most of the constraints experienced by the farmers were associated with poverty. For example lack of information on adaptation to climate change could be attributed to the fact that research on climate change and adaptation options have not been strengthened in the country and thus, information is lacking in the area. Lack of money hinders farmers from getting the necessary resources and technologies which assist to adapt to climate change, as adaptation to climate change is costly.

Nzeadibe *et al.* (2011) studied Farmers' perception of climate change governance and adaptation constraints in Niger Delta region of Nigeria and reported inadequate information, low awareness level, poor government attention to environmental issues and lack of access to improved crop varieties as the major constraining factors to climate change adaptation in the region. Other constraints include ineffectiveness of indigenous methods, limited knowledge on adaptation measures, low institutional capacity and absence of government policy on climate change.

**Table 5.20: Distribution of respondents according to constraints to use of CCAP**

| Constraints | Kebbi State (n=279) | | Sokoto State (n=187) | | Zamfara State (n=56) | | Pooled Sample (n=522) | |
|---|---|---|---|---|---|---|---|---|
| | Freq | % | Freq | % | Freq | % | Freq | % |
| 1. Low income level | 244 | 87.46 | 155 | 82.89 | 49 | 87.50 | 448 | 85.82 |
| 2. High cost of improved rice varieties | 240 | 86.02 | 145 | 77.54 | 49 | 87.50 | 434 | 83.14 |
| 3. Poor access to information relevant to adaptation | 215 | 77.06 | 160 | 85.56 | 42 | 75.00 | 417 | 79.89 |
| 4. Non availability of processing facilities for value chain addition | 195 | 69.89 | 130 | 69.52 | 35 | 62.50 | 417 | 79.89 |
| 5. Low literary level | 209 | 74.91 | 126 | 67.38 | 43 | 76.79 | 378 | 72.41 |
| 6. Inadequate organic fertilizer | 147 | 52.69 | 97 | 51.87 | 29 | 51.79 | 378 | 72.41 |
| 7. Inadequate financial resources to adapt | 212 | 75.99 | 124 | 66.31 | 42 | 75.00 | 378 | 72.41 |
| 8. Inadequate knowledge on how to cope | 202 | 72.40 | 129 | 68.98 | 38 | 67.86 | 369 | 70.69 |
| 9. High cost of farm labour | 195 | 69.89 | 123 | 65.78 | 36 | 64.29 | 354 | 67.82 |
| 10. High cost of constructing irrigation and drainage systems | 179 | 64.16 | 125 | 66.84 | 41 | 73.21 | 345 | 66.09 |
| 11. Poor response to climate change related issues | 202 | 72.40 | 103 | 55.08 | 39 | 69.64 | 344 | 65.90 |
| 12. High cost of diversification of enterprise | 187 | 67.03 | 116 | 62.03 | 38 | 67.86 | 341 | 65.33 |
| 13. Limited access to improved rice varieties | 174 | 62.37 | 122 | 65.24 | 38 | 67.86 | 334 | 63.99 |
| 14. Poor response to crises related to climate change | 171 | 61.29 | 123 | 65.78 | 32 | 57.14 | 326 | 62.45 |
| 15. Inadequate government policies on climate change adaptation and mitigation | 175 | 62.72 | 98 | 52.41 | 35 | 62.50 | 308 | 59.00 |
| 16. Inefficient water harvesting methods | 154 | 55.20 | 109 | 58.29 | 35 | 62.50 | 298 | 57.09 |
| 17. Planting before rains result to crop | | | | | | | | 55.75 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| failure | 140 | 50.18 | 122 | 65.24 | 29 | 51.79 | 291 | |
| 18. High cost of land | 153 | 54.84 | 107 | 57.22 | 31 | 55.36 | 291 | 55.75 |
| 19. Poor extension services | 159 | 56.99 | 99 | 52.94 | 30 | 53.57 | 288 | 55.17 |
| 20. Use of zero tillage encourages weed growth, pest and disease attack | 137 | 49.1 | 93 | 49.73 | 30 | 53.57 | 260 | 49.81 |
| 21. Use of zero tillage encourages erosion | 135 | 48.39 | 90 | 48.13 | 32 | 57.14 | 257 | 49.23 |
| 22. Poor social network | 120 | 43.01 | 99 | 52.94 | 30 | 53.57 | 249 | 47.70 |
| 23. Lack of irrigation scheme | 123 | 44.09 | 70 | 37.43 | 22 | 39.29 | 249 | 47.70 |
| 24. Lack of access to weather forecasts | 122 | 43.73 | 93 | 49.73 | 25 | 44.64 | 240 | 45.98 |
| 25. Poor land ownership system | 125 | 44.80 | 75 | 40.11 | 24 | 42.86 | 224 | 42.91 |
| 26. Ineffectiveness of indigenous strategies | 97 | 34.77 | 70 | 37.43 | 23 | 41.07 | 190 | 36.40 |
| 27. Limited availability of land | 96 | 34.41 | 59 | 31.55 | 21 | 37.50 | 176 | 33.72 |
| 28. Farm size | 55 | 19.71 | 59 | 31.55 | 15 | 26.79 | 129 | 24.71 |

### 5.15.1 Suggested solutions to the constraints to use of climate change adaptation practices by the respondents

Table 5.21 shows that only about11% of the respondents did not offer any solution to the constraints. Majority those who offered solutions, about87% in Kebbi State, 95% in Sokoto State and 80% in Zamfara State suggested the provision of farm inputs on credit as a possible solution to the constraints associated with high cost or poor finance.Therefore, 89% of them suggested the provision of farm inputs on credit as a possible solution to the constraints associated with high cost or poor finance. In this regard, majority of the respondents, about87% in Kebbi State, 92% in Sokoto State and 80% in Zamfara State suggested the provision of loans by government and other stakeholders in agricultural finance. Overall, about88% of them suggested the provision of loans by government and other stakeholders in agricultural finance.

**Table 5.21: Distribution of respondents according to suggested solutions to the constraints to use of climate change adaptation practices**

| | Kebbi State (n=279) | | Sokoto State (n=187) | | Zamfara State (n=56) | | Pooled Sample (n=522) | |
|---|---|---|---|---|---|---|---|---|
| **Suggested Solutions** | **Freq** | **%** | **Freq** | **%** | **Freq** | **%** | **Freq** | **%** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Provision of farm inputs on credit | 243 | 87.10 | 177 | 94.65 | 45 | 80.36 | 465 | 89.08 |
| Provision of loans | 242 | 86.74 | 172 | 91.98 | 45 | 80.36 | 459 | 87.93 |
| Awareness campaign on climate change adaptation practices | 160 | 57.35 | 144 | 77.91 | 30 | 53.57 | 334 | 63.99 |
| Mass literacy education | 109 | 39.07 | 123 | 65.78 | 23 | 41.07 | 255 | 48.85 |
| Provision of adequate extension services | 87 | 31.18 | 61 | 32.62 | 20 | 35.71 | 168 | 32.18 |
| Rapid response to emergency situations caused by climate change | 97 | 34.77 | 40 | 21.39 | 15 | 26.79 | 152 | 29.12 |
| None | 38 | 13.62 | 9 | 4.81 | `11 | 19.64 | 58 | 11.11 |

Awareness campaign on climate change adaptation practices was also suggested by about57% in Kebbi State, 78% in Sokoto State and 54% in Zamfara State, with about64% overall, making that suggestion.Other possible solutions to the constraints suggested by the respondents include mass literacy education (about49%),provision of adequate extension services (32%)and rapid response to emergency situations caused by climate change (29%) (Table 5.21).

In a review of farm level adaptation strategies to climate change in Africa, Mohammed *et al.* (2014) suggested that addressing climate change is central to the sustainable development, economic growth and poverty reduction agenda. That in order to reduce the effects of climate change, adaptation strategies become imperative.They recommended that climate change awareness campaigns are needed to sensitize the farmers about the challenge and its implications in order to facilitate the promotion and adoption of adaptation strategies, adding that these farmers already operate in the marginal areas and had already adopted some coping strategies to the harsh climatic conditions that have prevailed over the years as these can serve as useful entry points for intervention.

Mohammed *et al.* (2014), also, recommended the need to increase smallholder farmers' productive capacity so that they can improve their asset base which will place them on a strong footing to adapt to climate change. This according to them, will improve national and household food security, incomes, and reduce poverty and environmental degradation.

# CHAPTER SIX

## SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter presents the summary, conclusion and recommendations based on the findings of this study.

### 6.5 Summary

This study assessed the factors influencing use of climate change adaptation practices among rice farmers in Kebbi, Sokoto and Zamfara States of North-West Nigeria. It specifically described the socio-economic characteristics of rice farmers in the study area; determined the level of awareness of climate change by rice farmers and described the climate change adaptation practices employed by rice farmers. Other specific objectives include assessing the perceived effects of climate change on rice production among farmers in the study area; examining the farmers' attitude to use of climate change adaptation practices; determining the factors influencing the use of climate change adaptation practices among rice farmers; and describing the constraints to use of climate change adaptation practices by the farmers.

A multistage sampling procedure was used to obtain a sample of 522 farmers out of 17,071 through a random selection. Data for this study were obtained with the aid of structured questionnaire. Findings on the socioeconomic characteristics of the rice farmers showed that majority (about 62%) of the respondents fell within the range of 41–60 years, which implied that most of the famers were relatively young and physically active. They were males (about94%) and married (88%), primarily farmers (89%) with a household size of 10-19 individuals.

Among the climate change adaptation practices was portfolio diversification,which involves the use of improved rice varieties and intercropping. Result of this study shows that majority (about85%) of the respondents used improved rice varieties and intercropping (77%). Soil conservation practices used involvedmulching, planting of cover crops, planting of trees, moderate use of fertilizers, moderate use of chemicals and use of organic manure. Mulching was used by only 34% of the respondents.

The chi-square test shows the relationship between farmers' perceived effects of climate change on rice production and rice yield. There is a significant relationship at 1% ($p<0.00$) level between farmers' perceived effects of climate change on rice production and rice yield in the three States with a chi-square value of 272.6368. This result is similar for each of the States with chi-square values of 207.6015, 113.7748 and 20.6431 for Kebbi State, Sokoto State and Zamfara State, respectively.

Rice farmers' level of living was analyzed in terms of estimated amount of money spent on vehicles, electronics and land and housing as assets acquired after the production season under review. Many of the farmers had spent part of their rice income on purchase of vehicles and electronics while very few of them spent part of their rice income on land and housing. The study determined a significant ($p<0.00$) relationship between farmers' use of climate change adaptation practices and their level of living

Results of the regression analysis of relationship between factors affecting the use of climate change adaptation practices and perceived effects of climate change on rice production reveals that sex of the respondent negatively and significantly ($p<0.01$)influences farmer's perceived effect of climate change on rice production. Marital status was found to negatively and significantly ($p<0.05$)influence the respondents' perceived effect of climate change on rice production. Household size was also found to negatively and significantly ($p<0.05$)influence the rice farmers' perceived effect of climate change on rice production. Years of acquiring formal education was found to positively and significantly ($p<0.000$)influence farmers' perceived effect of climate change on rice production. Faming experience was found to negatively and significantly ($p<0.01$)influence respondents' perceived effect of climate change on rice production. Off-farm employment is statistically significant ($p<0.05$).

This study examined the farmers' attitude to use of climate change adaptation practices. The most positive attitude was expressed by the farmers in the use of organic manure having a role to play in soil conservation to minimize the effect of climate change which had the highest mean score of 4.22. It was closely followed by the need for use of climate change adaptation practices and the use of improved rice varieties minimizing the effect of climate change on rice yield both with mean score of 4.09. Rice farmers' personal view on digging of well and/sinking of bore-hole being important for production of irrigated rice had a mean score of 4.07.Chi-square test of relationship between attitude of rice farmers and use of climate change adaptation practices shows a significant ($p<0.01$)relationship with a chi-square value of 12.7952. This indicates that attitude of the rice famers is strongly associated with the farmers use of climate change adaptation practices.

To determine the factors influencing climate change adaptation practices, Tobit regression analysis was used. Results of the Tobit regression analysis show that sex is statistically significant ($p<0.10$) but has a negative coefficient which implies that use of climate change adaptation practices among rice farmers in the study area was higher among male farmers than their female counterparts. Education is statistically significant ($p<0.00$). Farming experience is statistically significant ($p<0.05$) level but has a negative sign and a p-value of 0.015. Farm size is statistically significant ($p<0.05$). It has a positive coefficient which implies that farm size had a strong influence on the use of climate change adaptation practices. Climate change awareness is significant ($p<0.00$) with a positive coefficient indicating that climate change awareness had a strong influence on the use of climate change adaptation practices.

Constraints to use of climate change adaptation practices were reported by the respondents. Majority (about86%) of them reported low income as a constraint to use of climate change adaptation practices. They (about83%) reported high cost of improved rice varieties as a constraint to use of climate change adaptation practices. About 80% of them were constrained by poor access to information relevant to adaptation. Non availability of processing facilities for value chain addition was also a constraint to majority (about80%) of the respondents.

It was concluded that years of formal education, farm size, climate change awareness, extension contact, years of cooperative membership and affordability of using climate change adaptation practices were the major factors influencing the use of climate change adaptation practices among rice farmers in North-West, Nigeria. It was recommended among others,the need for improving the extension agent-farmer contact by the State governments in order to make the agricultural extension service more functional and result oriented, a need for governments and indeed all stakeholders involved in financing agricultural production to make subsidize agricultural inputs readily available to farmers, most especially improved varieties that can tolerate the adverse effects of climate change, a need (for all stakeholders) to create or operationalize climate sensitive facilities such as irrigation and drainage systems for farmers' use and finding solution to poor response to climate change related issues.

**6.6 Conclusion**

Based on the findings of this study, it is concluded that rice farmers in North-West zone, Nigeria were in their productive ages. This has a direct bearing on the availability of able bodied manpower for agricultural production and also on the ease of use of climate change adaptation strategies. They were married with large household size which is believed to provide cheap labour that would assist in practices capable of mitigating the impacts of climate variability and change.

Acquisition of one form of formal education or the other by the farmers had impact on adaptation to changes in the climate since use of adaptation practices that could result in climate change adaptation is easier and faster among educated farmers than the uneducated ones. Their membership of cooperative societies gave them access to credit which enhances their possibility of adapting strategies that reduce the negative impact of climate change.

Portfolio diversification (use of improved rice varieties and intercropping), soil conservation (moderate use of fertilizers, moderate use of chemicals and use of organic manure), adjusting the planting calendar (early planting and early harvesting), minimum tillage (making mounds and digging ridges across slopes) and use of irrigation technologies (use of rivers/streams and digging of well) by the farmers could lower the adverse effect of climate change on rice production. Years of formal education, farm size, climate change awareness, extension contact, years of cooperative membership and affordability of using climate change adaptation practices were the major factors influencing the use of climate change adaptation practices among rice farmers in North-West, Nigeria. Other factors were sex, farming experience and weather information.

Sex of the farmer, marital status, household size and years of acquiring formal education are the factors influencing rice farmers' perceived effect of climate change on rice production. Other factors include faming experience, off-farm employment, weather information, climate change awareness and extension contact. Years of cooperative membership, affordability of using climate change adaptation practices and complexity of using climate change adaptation practices also influenced the rice farmers' perceived effect of climate change on rice production. Use of climate change adaptation practices by rice farmers' had increased their level of living through acquisition of vehicles, electronics and land and housing.

**A**ttitude of rice farmers to use of climate change adaptation practices influenced the use of the practices since it favoured the use of organic manure, need for use of climate change adaptation practices and use of improved rice varieties. It also favoured early planting, early harvesting, making mounds and digging ridges across slopes and use of rivers/streams.

High cost of improved rice varieties, poor access to information relevant to adaptation and non availability of processing facilities for value chain addition served as impediments to use of climate change adaptation practices by the farmers. Other sources of impediments include low literacy level, inadequate organic fertilizer, inadequate financial resources and inadequate knowledge on how to cope. High cost of farm labour, high cost of constructing irrigation and drainage systems, poor response to climate change related issues, high cost of diversification of enterprise, high cost of improved rice varieties and limited access to the improved varieties among others also impaired the use of climate change adaptation practices by the farmers.

**6.7 Recommendations**

**i.** It was found that a large proportion of the farmers had no extension contact. There is therefore the need for improving the extension agents-farmer contact by the State governments in order to make the agricultural extension service more functional and result oriented. This will provide solutions to the problems associated with use of farm inputs such as seeds, fertilizers, chemicals, farm machines and more importantly, creation of awareness for use of climate change adaptation strategies among farmers. Climate change **a**wareness creation among farmers should not depend mainly on radio and fellow farmers. Adult literacy programmes should also be established by the extension agencies. Seminars/workshops and meetings on climate change and related issues should also be organized the agencies.

ii. Some of the farmers had no access to agricultural credits and majority of those who accessed credit had a meagre amount (less than ₦105,000.00) from informal sources. Therefore, governments and indeed all stakeholders involved in financing agricultural production should make enough credits readily available to farmers, for more access to farm inputs most especially improved varieties of rice seeds that can tolerate the adverse effects of climate change.

iii. Findings for this study showed a comparatively low use of mulching, planting of cover crops and planting of trees by the farmers, as adaptation measures to climate change effects. Hence, there should be an awareness creation campaign by both governments and non-governmental organizations concerned with agricultural development to educate the farmers on the importance of mulching, planting of cover crops and trees for soil conservation.

iv. Based on the constraints of low income and high cost of constructing irrigation and drainage systems, there is need for all stakeholders (both governments and non-governmental organizations) concerned with climate change adaptation and agricultural development to create or operationalize the existing climate sensitive facilities such as irrigation and drainage systems for farmers' use. This will increase the smallholder farmers' productive capacity so that they can improve their asset base which will place them on a strong footing to adapt to climate change.

v. In finding solution to poor response to climate change related issues, governments at all levels should show more concern to the plight of farmers especially under emergency situations like floods, drought, pests and diseases e.t.c. This can be achieved by improving the services rendered by the emergency management agencies in the LGAs, States and at national level.

### 6.8 Contributions to Knowledge

This study made the following contributions to knowledge:

i. This study established that over 74% of rice farmers in North-West zone, Nigeria are either fully or partially aware of climate change

ii. It was found that rice farmers in the zone mainly rely on radio (97.19%) and fellow farmers (93.01%) for information climate change.

iii. Most of the rice farmers used improved rice varieties (84.48%), intercropping (77.40%),recommended levels of fertilizers (93.10%) and chemicals (89.85%) and manure (99.43%) as climate change adaptation practices.

iv. They also adjusted the planting calendar through early planting (92.34%)and early harvesting (93.10%) to adapt to climate change.

v. As a climate change adaptation strategy, the farmers made mounds and/or ridges across slopes (89.85%),used rivers/streams(96.17%) and dug wells (89.08%) for irrigation.

vi. However, only 33.91% of the farmers used mulching, 28.54% planted of cover crops and 40.61% planted trees, which are important climate change adaptation practices.

vii. Many of the farmers had spent part of their rice income on purchase of vehicles (50.77%) and electronics (53.64%) as major physical assets acquired after the production season under review to improve their level of living, which was found to be significantly ($p<0.00$) related to their use of climate change adaptation practices.

viii. Factors influencing the use of climate change adaptation practices among rice farmerswere found to include,education, extension contact, cooperative membership climate change awareness, weather information, sex and affordability of using climate change adaptation practices (p<0.01).

ix. Constraints to use of climate change adaptation practices by the farmers include low income (85.82%), high cost of improved rice varieties (83.14%) and poor access to information relevant to adaptation (79.89%) among others.

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# APPENDICES

**Appendix I**

**AHMADU BELLO UNIVERSITY, ZARIA**
**FACULTY OF AGRICULTURE**
**DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY**
**FARMER QUESTIONNAIRE**

Dear Sir/Madam,

I am a postgraduate student of the above named institution conducting a Ph. D research on the Factors Influencing the Use of Climate Change Adaptation Practices among Rice Farmers in Three States of North-West, Nigeria.

Kindly answer the under listed questions with utmost sincerity. You are assured of absolute confidentiality with regards to the information given, as this exercise is carried out purely for research purpose.

Thank you.

Danlami Haruna YAKUBU.

**Background Information**

1. Nameof farmer: ……...............…………………………………………………….

2. Phone Number …………………………………………………………………
3. Village: ……………………………....……………………………………..
4. LGA: ……………………………………….…………………………….
5. State: ………………………………………………......………………….
6. Name of enumerator: ………………………………………………………….
7. Date of interview: …………………………………………………………..

**Section A: Socioeconomic Characteristics of the Rice Farmer**

8. Age: …………………years
9. Sex: Male ( ) Female ( )
10. Occupation: Major ………………………….. Minor …………………………. …..
11. Marital status: a) Married ( ) b) Single ( ) c) Divorced ( ) d) Widow or Widower ( )

12. Provide information on your educational attainment in the following table:

| | **Educational Attainment** | **Number of Years** |
|---|---|---|
| | **Non-formal education** | |
| i. | Islamic Education | |
| ii. | Adult Education | |
| | **Total** | |
| | **Formal education** | |
| i. | Primary Certificate | |
| ii. | Secondary Certificate | |
| iii. | OND | |
| iv. | HND | |
| v. | B. Sc/B.A | |
| vi. | M. Sc. | |
| vii. | Ph.D. | |
| viii. | Others (please specify): | |
| ix. | | |
| x. | | |
| | **Total** | |

13. Are you the head of your household? Yes ( ) No ( )
14. Number of wives…………………………………………………….……………..
15. Provide the information on your children and other dependents in the following table:

| **S/no** | **Children/Dependents** | **Number less than 18 years old** | **Number 18 years and above** |
|---|---|---|---|
| i. | Male children | | |
| ii. | Female children | | |
| iii. | Male dependents | | |
| iv. | Female dependents | | |
| | Total | | |

16. Years of farming experience: …………………………………………………years
17. Do you belong to any cooperative society/farmers' associations? Yes ( ) No ( )
18. If yes, for how long? .......................................................................................years
19. Do you have access to loan? Yes ( ) No ( )
20. If yes, what is/are your source(s) of loan (money)?

    a) Informal sources (e.g. friends, neighbours, family members) ( )
    b) Private Commercial Banks ( )
    c) Government Loan scheme ( )
    d) Non-Governmental organizations ( )
    e) Others (Please specify) …………………………………………….................
21. How much did you obtain from your source(s) of loan in the last rice production period (2015)? ₦ .........…………………………………………………………

22. Do you have access to credit? Yes ( ) No ( )

23. If yes, what is/are your source(s) of credit (farm inputs)?
    a) Informal sources (e.g. friends, neighbours, family members) ( )
    b) Private Commercial Banks ( )
    c) Government Loan scheme ( )
    d) Non-Governmental organizations ( )
    e) Others (Please specify): …………………………………………………………
24. Do you have any off- farm employment? Yes ( ) No ( )
25. If yes, mention it: …………………..…………………………………………………
26. How much do you earn in a year, from the off-farm employment …………………..₦
27. Do you have extension contacts? Yes ( ) No ( )
28. If yes, how many times did you receive extension contacts last season (2015)? ……..................................................................................................................
29. How many times did you visit extension agent(s)/agency last season? ……………………..................................................................................................
30. What is your most frequent mode of communication with the extension agents/agency?
    a) Face to face ( ) b) Electronics (radio, telephone, television etc) ( ) c) Printed materials (newspapers, magazines, bulletins etc.) ( ) f) Others (please specify): …….…………………………………………………………………………...
31. Did you obtain any intervention or aid to improve your level of production? Yes ( ) No ( )
32. If yes, from who?
    a) Federal government ( )
    b) State government ( )
    c) Local government ( )
    d) Others (please specify): ……………………………………..............................
33. What is the nature of the intervention or aid?
    a) Loan (money) ( )
    b) Credit (farm inputs) ( )

c) Capacity building ( )
d) Others (please specify): ..........................................................................................

34. If loan, how much? ₦ ……………………………………………………..........................
35. If credit (farm inputs), name them: .......................................………………………
36. Estimate the total value of the inputs: ₦ ……………….............................................
37. Did the intervention assisted in any way, in your use of climate change adaptation practices? a) Yes ( ) b) No ( )
38. If no, suggest the best way(s) for suitable intervention:
    a) Loan ( )
    b) Credit ( )
    c) Capacity building ( )
    d) Others (please specify) ………………………………….....................................

**Section B: Level of Climate Change Awareness of the Farmer**

39. Are you aware of climate change? Yes ( ) No ( )
40. If yes, what is climate change?
    (Rate the farmer, based on his response to question 40 by ticking in the following table as appropriate)

| **Not aware (1)** | **Partially aware (2)** | **Fully aware (3)** |
|---|---|---|
| | | |

41. How long have you been aware of climate change? …………………….............. years

42. Which of the following is/are responsible for climate change?
    a) Destruction of vegetation/trees ( )
    b) Super natural forces/God ( )
    c) I don't know ( )
    d) Poor farming practices ( )

43. Have you been invited to attend a seminar/workshop or meeting on climate change? Yes ( ) No ( )
44. If yes, did you attend? Yes ( ) No ( )
45. If yes, what information about climate change can you remember? ……………………………………………………………………………………….....

46. Do you have access to weather information? Yes ( ) No ( )
47. If yes, through what channel?
    a) Radio ( )
    b) Television ( )
    c) Newspaper ( )
    d) Extension agents ( )
    e) Research institutes ( )
    f) Cooperative societies ( )
    g) Internet ( )

**h)** Fellow farmers ( )
i) Others (please specify): ……………………………………………………………....

48. How relevant is the weather information to you?
a) Not relevant ( ) b) Relevant ( ) c) Very relevant ( )

**Section C: Use of Climate Change Adaptation Practices**

49. Kindly rank each of the following climate change adaptation practices based on your level of usage from 1-3 (Note: 1 = low, 2 = medium and 3 = high). Indicate the source and number of years of usage.

| **Climate change adaptation practices** | | **Rank (1-3)** | **Source** | **Years of usage** |
|---|---|---|---|---|
| 1) | **No Adaptation** | | | |
| 2) | **Portfolio Diversification:** | | | |
| i. | Use of improved rice varieties | | | |
| ii. | Intercropping | | | |
| 3) | **Soil Conservation:** | | | |
| i. | Mulching | | | |
| ii. | Planting of cover crops | | | |
| iii. | Planting of trees | | | |
| iv. | Moderate use of fertilizers | | | |
| v. | Moderate use of chemicals | | | |
| vi. | Use of organic manure | | | |
| 4) | **Adjusting the planting calendar:** | | | |
| i. | Early planting | | | |
| ii. | Late planting | | | |
| iii. | Early harvesting | | | |
| iv. | Late harvesting | | | |
| 5) | **Use of minimum tillage:** | | | |
| i. | Zero tillage | | | |
| ii. | Making mounds and digging ridges across slopes | | | |
| 6) | **Irrigation:** | | | |
| i. | Rainwater harvesting | | | |
| ii. | Use of rivers/streams | | | |
| iii. | Digging of well | | | |
| iv. | Sinking of bore-hole | | | |
| 7) | **Insurance** | | | |

50. Have you ever migrated due to climate change? Yes ( ) No ( )
51. If yes, which of the following caused your migration?
a) Rice failure due to drought ( )
b) Rice failure due to floods ( )
c) Destruction of your house by floods ( )
d) Others (please specify): ……………………………………………………………...
52. Did you use pesticides last season? Yes ( ) No ( )

53. If yes, name the pesticides used ……………………………………………………..
54. Estimate the quantity of the pesticides used ………………………… litres/ha or kg/ha
55. Did you use inorganic fertilizers last season (2015)? Yes ( ) No ( )
56. If yes, name the fertilizers used ……………………………………………………..
57. Estimate the quantity of fertilizers used …..……..……………………………… kg/ha
58. Estimate your total rice output last season.…………………………………....... kg.
59. Indicate below, what you achieved or acquired including the estimated amount used from rice production.

| S/N | Level of Living | Estimated Amount from Rice Production (₦) |
|---|---|---|
| i. | Savings | |
| ii. | Pilgrimage to Mecca | |
| iii. | Got married | |
| iv. | Acquired bicycle(s) | |
| v. | Acquired motorcycle(s) | |
| vi. | Acquired vehicle(s) | |
| vii. | Acquired land(s) | |
| viii | Built house(s) | |
| ix. | Paid school fees | |
| x. | Acquired furniture | |
| xi. | Purchased television(s) | |
| xii. | Acquired DVD | |
| xiii | Installed satellite | |
| xiv | Purchased radio | |
| xv. | Purchased handset | |
| xvi | Purchased other electronics | |
| xvi | Sponsored a naming or other ceremonies (such as Sallah) | |
| xvi | Food items in store for the household | |
| xix | Paid medical bills | |
| xx. | Purchased farm inputs against next production season | |
| xxi | Purchased new clothes | |
| xxi | Purchased other items for use in the house | |
| xxi | Others (please specify): | |
| xxi | | |
| xx\ | | |
| xx\ | | |

60. How did you acquire your land?
   a) Inheritance ( ) b) purchase ( ) c) rent/lease ( ) d) gift ( ) c) Others (please specify)……………………………………………………………………….........
61. What is your total land size? ………………………………..…………………..... ha.
62. What is the land size for rice only? …………………………………………………ha.
63. What portion of the land did you produce rice last season (2015)? ……………………… ha.

64. Estimate the value of other products obtained besides rice output ……….………. ₦.

65. What system of cropping did you use?
   a) Sole ( )
   b) Mixed ( )
   c) Others (please specify)……………………………………………………………

66. What rice system did you use last season?
   a) Dry Upland ( )
   b) Waterlogged/Lowland (*Fadama*) ( )
   c) Both ( )

67. Based on water supply what did you depend on for rice production?
   a) Rainfall ( )
   b) Irrigation ( )
   c) Both ( )

68. What other crops do you grow apart from rice? …………………………………………………………………………………......

69. Choose the appropriate attribute for each of the climate change adaptation practices as applicable to you (Note: Af = Affordable, Un = Undecided, NAf = Not Affordable, Us = Usable, Un = Undecided, UUs = Unusable, Ad = Advantageous Un = Undecided and NAd = Non Advantageous

| **Climate change adaptation practices** | | **Affordability** | | | **Complexity** | | | **Relative advantage** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Af** | **Un** | **NAf** | **Us** | **Un** | **UUs** | **Ad** | **Un** | **NAd** |
| 1) | **No Adaptation** | | | | | | | | | |
| 2) | **Portfolio Diversification:** | | | | | | | | | |
| i. | Use of improved rice varieties | | | | | | | | | |
| ii. | Intercropping | | | | | | | | | |
| 3) | **Soil Conservation:** | | | | | | | | | |
| i. | Mulching | | | | | | | | | |
| ii. | Planting of cover crops | | | | | | | | | |
| iii. | Planting of trees | | | | | | | | | |
| iv. | Moderate use of fertilizers | | | | | | | | | |
| v. | Moderate use of chemicals | | | | | | | | | |
| vi. | Use of organic manure | | | | | | | | | |
| 4) | **Adjusting the planting calendar:** | | | | | | | | | |
| i. | Early planting | | | | | | | | | |
| ii. | Late planting | | | | | | | | | |
| iii. | Early harvesting | | | | | | | | | |
| iv. | Late harvesting | | | | | | | | | |
| 5) | **Use of minimum tillage:** | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| i. | Zero tillage | | | | | | | | | |
| ii. | Making mounds and digging ridges across slopes | | | | | | | | | |
| 6) | **Use of technologies irrigation:** | | | | | | | | | |
| i. | Rainwater harvesting | | | | | | | | | |
| ii. | Use of rivers/streams | | | | | | | | | |
| iii. | Digging of well | | | | | | | | | |
| iv. | Sinking of bore-hole | | | | | | | | | |
| 7) | **Insurance** | | | | | | | | | |

**Section D: Perceived Effects of Climate Change on Rice Production**

70. Kindly rank each of the following statements on effects of climate change on rice production depending on how true or correct you perceive it.

Note: 1= low, 2 = moderate and 3= high effect

| S/N | Effects of climate change on rice production | Perception (1 - 3) |
|---|---|---|
| i. | Climate change poses risks to rice production | |
| ii. | Climate change presents more risks than benefits to rice production | |
| iii. | Continuous rise in annual temperature reduces production of rice | |
| iv. | Yearly rains are not supporting rice production as before | |
| v. | Infestation of rice by pest is common due to climate change | |
| vi. | Climate change reduces working hours of rice farmers | |
| vii. | There is poor germination rate of rice due to climate change | |
| viii. | Poor yield of rice cannot be due to climate change | |
| ix. | Climate change will boost rice production | |
| x. | Climate change will lower rice production | |
| xi. | Climate change does not lead to prevalence of rice diseases | |
| xii. | High cost of rice cannot be attributed to climate change | |
| xiii. | Climate change does not force rice farmers into planting different crops | |
| xiv. | Climate change does not lead to high production cost in rice | |
| xv. | Climate change has no effect on rice production | |
| xvi. | Climate change will continue to affect storage of rice | |

**Section E: Farmers' Attitude to Use of Climate Change Adaptation Practices**

71. Kindly tick any of the following options on the statements made based on your opinion on climate change.

Note: **SA**= Strongly Agreed, **A**= Agreed, **U** = Undecided, **D** = Disagreed and **SD** = Strongly Disagreed

| S/N | Attitudinal Statements | Options | | | | |
|---|---|---|---|---|---|---|
| | | SA | A | U | D | SD |
| i. | There is need for use of climate change adaptation practices | | | | | |
| ii. | Use of improved rice varieties can minimize the effect of climate change on rice yield | | | | | |
| iii. | Intercropping is necessary to avoid total crop failure due to climate change | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| iv. | Mulching is an important practice for soil conservation to minimize the effect of climate change | | | | | |
| v. | Planting of cover crops can help conserve soil to minimize the effect of climate change | | | | | |
| vi. | Planting of trees such as *Acacia spp* can play a significant role in soil conservation which minimizes the effect of climate change | | | | | |
| vii. | Moderate use of fertilizers has relationship with soil conservation in minimizing the effect of climate change | | | | | |
| viii. | Moderate use of chemicals is essential for soil conservation to minimize the effect of climate change | | | | | |
| ix. | Use of organic manure has a role to play in soil conservation to minimize the effect of climate change | | | | | |
| x. | Early planting can minimize rice failure due to late season drought which minimizes the effect of climate change | | | | | |
| xi. | Late planting has relevance in avoidance of early season drought to minimize the effect of climate change | | | | | |
| xii. | Early harvesting may be necessary to prevent the incidence of floods in rice fields caused by climate change | | | | | |
| xiii. | Late harvesting can minimize late season's erosions and floods caused by climate change | | | | | |
| xiv. | Zero tillage is an important soil conservation technique to minimize the effect of climate change | | | | | |
| xv. | Making mounds and digging ridges across slopes minimize erosions in the farm which minimizes the effect of climate change | | | | | |
| xvi. | Rainwater harvesting is a useful practice for saving water to minimize the effect of climate change | | | | | |
| xvii. | Use of rivers/streams makes it possible for rice production during dry season | | | | | |
| xviii. | Digging of well and/ sinking of bore-hole are important for the production of irrigated rice | | | | | |
| xix. | Insurance can serve against complete rice failure caused by climate change | | | | | |

## Section F: Constraints to Use of Climate Change Adaptation Practices

72. Kindly tick any of the following constraints to use of climate change adaptation practices affecting you and suggest the possible solutions to the constraints.

| **S/N** | **Constraints** | **Tick** | **Possible solutions** |
|---|---|---|---|
| i. | Poor access to information relevant to adaptation | | |
| ii. | Low literacy level | | |
| iii. | Poor social network | | |
| iv. | Limited access to improved rice varieties | | |
| v. | Farm size | | |
| vi. | Poor land ownership system | | |
| vii. | High cost of improved rice varieties | | |
| viii. | Non availability of processing facilities for value chain addition | | |
| ix. | Inadequate organic fertilizer | | |
| x. | Lack of irrigation scheme | | |
| xi. | High cost of constructing irrigation and | | |

| | | | |
|---|---|---|---|
| | drainage systems | | |
| xii. | Ineffectiveness of indigenous strategies | | |
| xiii. | Inadequate financial resources to adapt | | |
| xiv. | Poor extension services | | |
| xv. | Lack of access to weather forecasts | | |
| xvi. | High cost of farm labour | | |
| xvii. | Poor response to climate change related issues | | |
| xviii. | Inadequate government policies on climate change adaptation and mitigation | | |
| xix. | High cost of diversification of enterprise | | |
| xx. | Use of zero tillage encourages weed growth, pest and disease attack | | |
| xxi. | Use of zero tillage encourages erosion | | |
| xxii. | Planting before rains result to crop failure | | |
| xxiii. | Inefficient water harvesting methods | | |
| xxiv. | Inadequate knowledge on how to cope | | |
| xxv. | Poor response to crises related to climate change | | |
| xxvi. | Limited availability of land | | |
| xxvii. | High cost of land | | |
| xxviii. | Low income level | | |

73. What other serious constraints did you encounter in rice production as a result of climate change?
………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………

74. Suggest ways to overcome the constraints listed in question 73.
………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………

THANK YOU.

**Appendix II** **Tobit Regression Analysis**

```
(R)
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Notes:
      1.  (/m# option or -set memory-) 50.00 MB allocated to data
      2.  (/v# option or -set maxvar-) 5000 maximum variables

running C:\Users\Mallam Yakubu\Desktop\Stata11\profile.do ...

. *(19 variables, 522 observations pasted into data editor)

. tobit adpindex age sex hhs tnf fex fsz ofe ric caw cca cac ect wea ycm mas taf tco tra, ll
```

```
Tobit regression                          Number of obs   =        279
                                          LR chi2(18)     =     511.90
                                          Prob > chi2     =     0.0000
Log likelihood =  491.24853               Pseudo R2       =    -1.0878
```

| adpindex | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| age | -.0001969 | .0006286 | -0.31 | 0.754 | -.0014347 | .001041 |
| sex | -.0294055 | .0170122 | -1.73 | 0.085 | -.0629041 | .0040931 |
| hhs | -.0000544 | .0006753 | -0.08 | 0.936 | -.0013842 | .0012754 |
| tnf | .0082387 | .0008528 | 9.66 | 0.000 | .0065595 | .0099179 |
| fex | -.0015696 | .0006412 | -2.45 | 0.015 | -.0028321 | -.0003071 |
| fsz | .0187711 | .0080722 | 2.33 | 0.021 | .0028762 | .0346661 |
| ofe | .0114669 | .0118226 | 0.97 | 0.333 | -.0118128 | .0347466 |
| ric | -1.51e-08 | 2.31e-08 | -0.66 | 0.513 | -6.06e-08 | 3.03e-08 |
| caw | .0751906 | .0148369 | 5.07 | 0.000 | .0459754 | .1044058 |
| cca | -.0006179 | .000954 | -0.65 | 0.518 | -.0024965 | .0012607 |
| cac | -7.00e-08 | 7.51e-08 | -0.93 | 0.352 | -2.18e-07 | 7.78e-08 |
| ect | .0099623 | .0027722 | 3.59 | 0.000 | .0045036 | .015421 |
| wea | -.0148115 | .004841 | -3.06 | 0.002 | -.0243439 | -.0052791 |
| ycm | .0033329 | .0006337 | 5.26 | 0.000 | .0020851 | .0045807 |
| mas | -.0024656 | .0033044 | -0.75 | 0.456 | -.0089724 | .0040411 |
| taf | .0056819 | .0015448 | 3.68 | 0.000 | .00264 | .0087239 |
| tco | .0012794 | .0019081 | 0.67 | 0.503 | -.0024778 | .0050366 |
| tra | -.0006896 | .002261 | -0.31 | 0.761 | -.0051417 | .0037624 |
| _cons | .2272166 | .1606447 | 1.41 | 0.158 | -.089108 | .5435412 |
| /sigma | .0384185 | .0016612 | | | .0351475 | .0416895 |

```
  Obs. summary:          0  left-censored observations
                       271     uncensored observations
                         8 right-censored observations at adpindex>=.83333331
```

**Appendix III Linear Regression Analysis**

```
  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
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. *(23 variables, 523 observations pasted into data editor)
(variable named "tnf" already exists; using name "var11")

. regress tpc1 age sex hhs tnf fex fsz ofe ric caw cca cac ect wea ycm mas taf tco tra

```
      Source |       SS       df       MS              Number of obs =     279
-------------+------------------------------           F( 18,   260) =   93.69
       Model |  60.2586177    18  3.34770098           Prob > F      =  0.0000
    Residual |  9.28976943   260  .035729882           R-squared     =  0.8664
-------------+------------------------------           Adj R-squared =  0.8572
       Total |  69.5483871   278  .250174054           Root MSE      =  .18902

------------------------------------------------------------------------------
        tpc1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |   .0010737   .0030639     0.35   0.726    -.0049595    .0071069
         sex |  -.8655824   .0836575   -10.35   0.000    -1.030315   -.7008499
         hhs |  -.0068441   .0033084    -2.07   0.040    -.0133588   -.0003294
         tnf |   .0679474   .0041924    16.21   0.000      .059692    .0762028
         fex |  -.0108659   .0031397    -3.46   0.001    -.0170484   -.0046834
         fsz |  -.0355542   .0394834    -0.90   0.369    -.1133022    .0421938
         ofe |   .1235276   .0580493     2.13   0.034     .0092209    .2378343
         ric |   1.36e-07   1.14e-07     1.20   0.231    -8.73e-08    3.60e-07
         caw |  -.1344556   .0729364    -1.84   0.066    -.2780768    .0091657
         cca |  -.0029511   .0046879    -0.63   0.530    -.0121821    .0062798
         cac |  -1.71e-07   3.69e-07    -0.46   0.644    -8.98e-07    5.56e-07
         ect |   .0265562   .0135678     1.96   0.051    -.0001606     .053273
         wea |   -.067155   .0236541    -2.84   0.005     -.113733   -.0205769
         ycm |   .0052883   .0031142     1.70   0.091    -.0008439    .0114206
         mas |  -.0359333   .0162539    -2.21   0.028    -.0679394   -.0039272
         taf |   .0320443   .0075805     4.23   0.000     .0171173    .0469712
         tco |  -.0777233   .0093856    -8.28   0.000    -.0962048   -.0592418
         tra |  -.0061227   .0111214    -0.55   0.582    -.0280221    .0157768
       _cons |   5.165622    .790263     6.54   0.000     3.609491    6.721752
------------------------------------------------------------------------------
```

**Appendix IV** **Chi-square Analyses**

```
  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
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. *(9 variables, 522 observations pasted into data editor)

. tab tpcclass yldclass, chi2

           |          yld class
 tpc class |         1          2          3 |     Total
-----------+---------------------------------+----------
         1 |       231         23         28 |       282 
         2 |        29         80         24 |       133 
         3 |         2         85         20 |       107 
-----------+---------------------------------+----------
     Total |       262        188         72 |       522 

          Pearson chi2(4) = 272.6368   Pr = 0.000
  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
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```

```
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. *(9 variables, 279 observations pasted into data editor)

. tab tpcclass yldclass, chi2

           |          yld class
 tpc class |         1          2          3 |     Total
-----------+---------------------------------+----------
         1 |       115         20          0 |       135 
         2 |         0         58          6 |        64 
         3 |         2         63         15 |        80 
-----------+---------------------------------+----------
     Total |       117        141         21 |       279 

          Pearson chi2(4) = 207.6015   Pr = 0.000

  ___  ____  ____  ____  ____ (R)
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. *(9 variables, 187 observations pasted into data editor)

. tab tpcclass yldclass, chi2

           |          yld class
 tpc class |         1          2          3 |     Total
-----------+---------------------------------+----------
         1 |       101          1         15 |       117 
         2 |        27          8         10 |        45 
         3 |         0         21          4 |        25 
-----------+---------------------------------+----------
     Total |       128         30         29 |       187 
```

Pearson chi2(4) = 113.7748   Pr = 0.000

```
  ___  ____  ____  ____  ____ (R)
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. *(9 variables, 56 observations pasted into data editor)

. tab tpcclass yldclass, chi2

           |          yld class
 tpc class |         1          2          3 |     Total
-----------+---------------------------------+----------
         1 |        15          2         13 |        30 
         2 |         2         14          8 |        24 
         3 |         0          1          1 |         2 
-----------+---------------------------------+----------
     Total |        17         17         22 |        56 

          Pearson chi2(4) =  20.6431   Pr = 0.000
```